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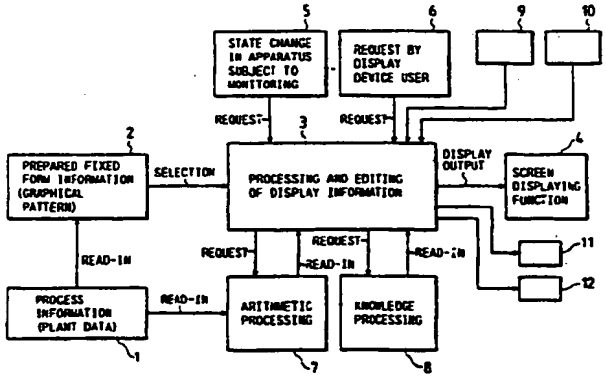
(54) A control system for an industrial plant, a display device for such a control system, and a method of controlling an industrial plant.

(57) A control system for an industrial plant receives plant data (1) and combines that plant data (1) with a plurality of graphical patterns (2) representing the plant. In this way a series of prepared displays are created to be displayed (4) for a user of the control system. If the user wants to simplify one or more of the displays, in order to make it more clear, the control system has means (3,7,8) for modifying the displays, and displaying that modified display. The modification may be one of a number of possibilities such as deletion (masking) part or all of the display. In this way, the full plant information may be presented, or more limited information may be presented e.g. to a more experienced user.

FIG. 1



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The present invention relates to a control system for an industrial plant. Such control systems have one or more display devices for displaying information relating to the plant, and the present invention is particularly concerned with such display displacers. The present invention also relates to a method of controlling an industrial plant.

Most complex industrial plants have at least one control with displays for displaying information about the operation of the plant, to enable an operator the user of the control to monitor the performance of the plant. It is frequently the case that a single display such as a CRT, VDU, or large-size screen is arranged to display several different bits of information, corresponding to different parts of the plant, for example, in practice, the control system stores one or more patterns representing the plant, which forms the basis of the display. Those patterns are made of a plurality of pattern elements, such as symbols representing pumps, valves, and lights for interconnecting them so that the pattern represents the plant. Furthermore, the control system receives plant data representing operating conditions of the plant, such as temperature or pressure at particular points, whether valves are open or closed, whether a pump is running or not, etc. The plant data is then combined with the patterns in a way which is preset, to form one or more prepared displays. The operator may then select one of those prepared displays, and display it when needed, or the apparatus may be arranged sequentially to display all those prepared displays.

At its simplest, the designer of the control system determines which plant data is to be displayed with a given pattern, so that the prepared patterns are entirely pre-set, and there is only one prepared display corresponding to each pattern.

However, such a system has a disadvantage. If the operator of the system is relatively inexperienced, it is often helpful for the display to display all the plant data relating to the part of the plant corresponding to a given pattern. Furthermore, explanatory information can also be displayed. The display then becomes complicated, the relative inexperience of the operator requires that complex information.

However, if the operator is already experienced, or an inexperienced operator learns more about the system, it then becomes less important for some of the plant data to be displayed. Then, the very complexity of the display tends to reduce the efficiency of the operator, because there is the risk of the operator becoming confused by the volume of information that is displayed. It is preferable, then for a simpler display to be provided, in which only that information is actually necessary or desired by the operator is displayed.

Japanese patent application laid-open 55-157009 seeks to solve this problem. It proposes that more than one prepared display is provided for a given pattern (e.g. corresponding to a particular part of the plant). Then, one of those prepared displays, may be relatively complete, for an inexperienced user, and another may be more simple for an experienced user. The operator then can switch between one prepared pattern and another, depending on his level of experience.

Further, Japanese patent application laid-open number 55-157009 also suggests that, for a given pattern, several prepared displays may be provided, each displaying different conditions, e.g. one displaying temperature conditions corresponding to the patent, another displaying pressure conditions corresponding to the pattern, etc so that the operator may select a particular group of plant data for observation.

In Japanese patent application laid-open number 55-157009, however, every display that is to be displayed has a corresponding prepared display, i.e. a different prepared display is needed for each particular manner of presentation. Thus, it may be desired to have one display of a particular pattern showing a large amount of information, and this will need one prepared dispaly, the further prepared display will be needed if that pattern is to be displayed with a more limited amount of information. The number of prepared displays is therefore large. Since a large amount of programming work (up to 3 days) may be required to produce each prepared display, the total amount of work is therefore large. Furthermore, a large memory is needed to store all the prepared displays.

According to the present invention, it is proposed that means be provided for modifying a given prepared display prior to its display by the display device of the control system. With such an arrangement, the number of prepared displays is reduced because, if a display is wanted for a given pattern and a large amount of data, and another display is wanted of same pattern and a more limited amount of data, then the prepared display may correspond to the former, and that prepared display is then modified to produce the latter. The modification of the prepared display may be one or more of a large range of possible modifications, which may be selected by the user or may be selected automatically. These modifications will be discussed in more detail later, but may be grouped into a number of different types:

1) deletion; modification may involve the deletion from the display of some of the plant data associated with a given pattern, so that only the necessary or desired data is displayed. This may be, for example, to simplify the display for an experienced user, or to collect a particular type of data (e.g. temperature, pressure, etc.,) for display.

This type of modification will be referred to subsequently as masking.

2. Change of intensity: rather than completely deleting plant data from the display, it is also possible for unnecessary or unuseful information to be reduced in intensity on display, so that the more important plant is more prominent. This type of modification is referred to later as "filming".

3. Translation; a further possible modification is to move some or all of the plant data, or even the whole of the pattern, on the display screen. There are two situations where this is important. Firstly, suppose several parameters are associated with e.g. a pattern element in the prepared pattern. Suppose then , that e.g. by deletion, some of those data are not displayed. Then, the displayed data may be spaced by a significant amount from the corresponding pattern element. Then, the modification may involve translation of that plant data to a position closer to the pattern element with which it is associated. A further alternative arises when the deleted data is extensive, so that a substantial part of the display is blank. Then, it is preferable for the whole of the remaining part of the display including the pattern, to be shifted so that it is approximately central in the display screen.

4. Change of colour; rather than mask or film unwanted data, it is possible for unimportant data to be displayed a different colour, so that the important data may readily be distinguished. Further alternatives within this type of modification include reverse colouring, in which the background and the data colours are reversed so that they are more readily visible.

5. Magnification; important data may be emphasised by making it appear larger on the display, although the display may be changed in size.

6. Periodic changes; as described above, all the modifications are static. However, it is also possible for e.g. important information to be flashed, so that it is more readily visible, by periodically carrying out some or all of the modifications discussed above, so that emphasis is given to the important information.

In a further development of the present invention, additional information may also be presented. For example, some plant data e.g. enthalpy is obtained by a calculation from other plant data. Then, the operator may choose whether that enthalpy data is displayed or not, and this may also be considered a modification of the prepared display. Yet another posibility is for additional indicators to be provided on the display, such as pointers to particularly important parts of the display.

It is preferable for the control system of the present invention to have a printer for providing a hard-copy print-out of the display. Such a hard-copy print-out may be triggered by the operator, or may be triggered automatically, e.g. when there is a malfunction of the plant. The hard-copy print-out may be of the modified display as actually presented on the display means, or may be the prepared display with all the information concerning the operation as planned.

It is also possible for more than one display to be presented simultaneously on a display screen, and each display may then be a modified prepared display.

As was mentioned above the present invention relates not only to a control system for the plant, but also relates to a method of operating such a control system, and to a display device and display method for such a control system.

Embodiments of the present invention will now be described in detail, by way of example, with reference to the accompanying drawings in which:

Fig. 1 shows a block diagram of a control system according to the present invention;

Fig. 2 is a block diagram illustrating in more detail part of the control system of Figure 1;

Fig. 3 is a block diagram of one component of the part of the control system shown in Figure 3;

Fig. 4 is a block diagram of another component of the part of the control system shown in Figure 3;

Fig. 5 is a block diagram of a further component of the part of the control system shown in Figure 2;

Fig. 6 is a block diagram of part of the component shown in Figure 4;

Fig. 7 is a block diagram of part of the component shown in Figure 5;

Fig. 8 is a block diagram showing the hardware components of the embodiments shown in Figure 1;

Fig. 9 shows schematically a comparative example of a known control system;

Figs. 10 to 25 illustrate displays which may be produced by the control system of the present invention; and

Figure 26 shows a block diagram of part of an embodiment of a control system having means for providing a hard-copy print-out of a display.

In the following description, the following terminology should be noted. As mentioned above, plant data representing operating parameters of the plant (therefore variable) is combined with a graphical pattern representing the plant (which is fixed and will be referred to as fixed form information) are combined to form a prepared display. That prepared display may be displayed on a suitable display device (CRT. VDU, etc.) or may be modified to form a modified display, before being displayed on the display device. For the sake of clarity, a display formed by that combination of a graphical pattern and plant data will be hereinafter

referred to as a "screen", this term applying both to modified and unmodified displays. Since the word "screen" is used for the information displayed, the component on which that "screen" is displayed will be referred to as a display device.

Figure 1 shows a block diagram representing, in functional terms, an embodiment of the present invention, being a control system for an industrial plant. Plant parameters, such a temperature, pressure, flow rate, operational states of components of the plant, etc., may be detected by suitable means not shown) and input to the control system. The control system then has a component 1 which converts those plant parameters to plant data. i.e. information representing the process being carried on by the plant. That processed information is transmitted to component 2 in which it is combined with corresponding graphical pattern, i.e. information pre-prepared in fixed form. The combined process information and fixed form information produce a plurality of prepared displays, and one or more of those prepared displays is then selected and transmitted to a component 3 which carries out modification of that prepared display, and the modified display may then be displayed by a suitable display device 4, and may also be copied onto a hard-copy print-out by means of a display screen copying component 11. A selection of the screen information to be processed and displayed may be printed out automatically in accordance with changes in the state of the components of the plant which are being monitered. e.g. such changes in the components subject to monitoring such as "operational phases or start-up or shut-down" , "operating situations (running), stopping etc," "non-normal state" and the like, or in accordance with a request 6 activated by the user of the display device. Such a request may include a request for a classified display of the display processors, a request for a classified display of steam systems, water systems, etc, a request for the display of the computer value of states of the process, such as enthalpy, entropy, etc., request for display of a pre-estimated value of a pre-estimated trend of a process being carried on by the plant, a request for the display of the deviation of a deviation of a parameter from a normal value or a standard value, a request for a display of deviation of a plant parameter from safety conditions, a request for a display of the deviation in a plant parameter during a change etc.

The information displayed on the display device may include plant data which is computed by an arithmatic process function component - only when requested. Such plant data may include enthalpy, entrophy, etc., furthermore, if unnecessary pieces of information are excluded from the modified display to be displayed on the display device 4, the display may become unbalanced, and this may be detected by a knowledge processing function component 8 which causes the parts of the display to be moved on the display device screen, so that a modified display is balanced.

Of course, presentation of any particular display on the display device 4 is unnecessary if the operator is not present. Therefore, means 9 may be provided for detecting the presence of the operator. Also, since the operator must be taking note of the displays presented on the display screen, a display information function device 12 may be provided showing that a particular display has been automatically displayed. In the case of an automatic display, it is then possible to provide automatic deletion of the displayed display after a predetermined time limit.

As was mentioned above, one reason for modification of a prepared display in dependence on the amount of experience posessed by operator. Therefore, the system may have a device 10 for indicating to the rest of the control system the skill level of the operator. For example the device 10 may receive an ID card identifying the operator, and the amount of plant data to be displayed may be etermined in accordance with the skill of the operator.

Various operations for modifying the prepared displays have been mentioned above. The most important is the process and editing function carried out by component 3, and the effect of this function on a screen displayed by a display device of the control system will now be described.

Figure 2 is a diagram representing the functional steps of the processing and editing function carried out by the components on information presented in a screen. The various information for a screen fed to the processing component 3 by the components 5, 6, 9 and 10 shown in Figure 1 are ordered into a priority order on the basis of priority processing request 20, and that priority is stored in a priority order memory 25. That stored priority order determines the order of selection of information from the plurality of text form information (i.e. graphical patterns representing the plan) stored in component 2, and then that information is subject to a process operation 22 and an editing operation 23. If the control system has a plurality of display devices for displaying process and editing screens, an appropriate display device is selected by a display device selection step 24, and display of the appropriate screen is carried out. The operation of the display device is generated so that the user of the display device can take note of the screen displayed when that screen is displayed automatically. Moreover, the device 11 for copying a screen onto hard-copy may be provided, and may carry out the following operations:

(1) On the basis of information excluded from the screen by masking or similar operations can also be printed on the hard-copy. It can be seen that the most important feature of the screen as displayed on the display device is visual clarity, whereas the total amount of information may be more important on a hard-copy.

(2) It is possible for such printing to occur not only at the request of the operator, who signals via component 6, but also when there is a change in state in the plant being controlled, which may be signalled via component 5. For example, if an accident occurs in the plant, the component 5 may reach for the screen including information about the plant to be copied automatically.

Referring now to Fig. 26, a prepared display (basic screen) at a functional block 261 is combined with one or more items of mark screen information from functional blocks 262, 263, 264. This combination occurs at functional block 265, which stores screen overlapping information, and thus generates display screen information at functional block 266.

Means 267 for generating a hard copy is suitable between the functional block 261 and the functional block 267 so that a hard copy can be generated. Thus, as shown in Figure 26, when a screen copying instruction is given, that instruction may be to copy a screen as actually displayed (display screen) (i.e. the hard copy block 267 as connected to the block 266) or may copy the underlying prepared display (referred to as a basic screen) (i.e. the hard copy block 267 is connected to the block 261). The copy may be of the basic screen or the displayed screen. Fig. 26 also shows a functional block 268 for monitoring the display screen information.

Figure 3 is a flow diagram showing the processing of priority requests 20, referred to above. When a plurality of requests are transmitted, the first step is advanced processing to confirm acceptance and order the requests, and this is carried out by step 200. Then, a step 201 carries out priority processing to determine which screen to select, and then a step 201 carries out priority processing of the display device on which the screen is to be displayed.

In some cases, it may be necessary to interrupt the display of a screen, e.g. to display another screen, and in this case it is necessary to process a signal requiring urgent interruption of the display screen, which is carried out at step 203. Furthermore, there may also be requests that no screen be displayed, and such display excluding processing is carried out by step 204. The order of these various processes is determined by processing step 209, and the priority order those determine is taught in a priority order memory 25. Then, if a screen selected with the highest priority is subsequently deleted, the screen with the next priority can then be selected.

Based on the priority processing discussed above with reference to Figure 3, the processing of information on a screen to modify that screen will be carried out.

Figure 4 shows the processing steps of the processing operation 22 in Fig. 2, namely the processing of fixed form screen information. After preprocessing by step 220 of the arithmatic processing 7 referred to with reference to Fig. 1, the following processes are carried out:

1. Masking of unnecessary information. Suppose that there is a screen display operating situations of plant situations, operating situations of an apparatus, and process conditions such as pressure, temperature, flow rate etc. Then, suppose that the user inputs a request for a more limited display of information, for example to display only information concerning pressure, or to display only information concerning the parts of the system that are running, other information is masked by the masking processes 221, and so will not be displayed. To achieve this masking, each screen may be divided up, in advance, into a plurality of areas, and then masking is achievable by either masking or not masking one or more of those areas. Thus, many masking possibilities exist. For example, if there are small n masking areas on one screen, 2^n screen variations exist.

2. Filiming of unnecessary information

In the masking process described above, unnecessary information is masked and thereby excluded from the display of the screen. In the filiming process, shown at step 222, a related operation is carried out in which the unnecessary information is made less prominent on the screen, which thus has the effect of making the desired information more prominent. Filming can be achieved by defining areas of the screen in a similar way to that done for the masking operation.

3. Colouring of desired information

The above steps (1) and (2) make unnecessary information less prominent or cancel it totally from the display of the screen. However, it is also possible to make the desired information more prominent, by displaying it in a different colour. This may be carried out at step 223.

4. Enlarging of desired information

It is also possible to change the size of the desired information, at step 224, to make the desired information more prominent.

5. Flickering of desired information

Process step 225 may arrange for desired information to be caused to flicker on the screen, thereby making it more prominent.

6. Other processes

There are other operations which may be carried out in the screen, and these are shown in Fig. 4 by step 226, and are illustrated in more detail in Fig. 6. In fact, this step may include one or more of a number of different possibilities such as:

a) animation masking, in which the masking of part of the screen is turned on and off periodically. For example, this is applicable to the display of a start-up operation within a piping system, in which the piping system is divided up into a number of areas, and those areas are alternately masked and unmasked, with this operation being applied in opposite senses to adjacent parts of the piping system.

b) animation filiming may provide a similar effect to a) above, but for a filiming process rather than a masking process.

c) reversed display processing, in which the colours of desired information, and the background colour of the screen, are reversed relative to the rest of the screen, thereby increasing the prominence of the desired information. This operation is not confined to reversal of colours, however, and other methods such as decolouring may also be applied.

Any one or more of the operations 221, 222, 223,224,225 and 226 in Fig. - may be applied to a screen signal, as requested by a user, and then the outputs of the various processes are combined at a post-processing step 229 to permit the modified screen to be displayed.

Fig. 5 illustrates the operation of screen editing. A screen processed by the operations shown in Fig. 4 is then input into the editing process 23 in Fig. 1, and this is shown in detail in Fig. 5. As shown in Fig. 5, an advanced processing step 230 receives the screen information, and then one or more of the following processes may be carried out:

1. Additional processing of arithmatic information.

It may be desired for the screen to display additional information to that supplied, by performing arithmatic operations on the original data. For example, enthalpy may be calculated using pressures and temperatures, rates of change may be calculated from changes in the amounts present, and such calculations may be achieved by an arithmatic processing step 231.

2. Adjustment of display area

Suppose that a screen displays flow rate, pressure, and temperature of a fluid flowing inside the pipe in a display of a piping system. Suppose then that the user desires to exclude from the display both the rate and temperature. Then, only the pressure is displayed and, depending on the masking areas, the display of temperature may be spaced from the display of the pipe to which it relates. Then, there may be some confusion in relating the pressure display to the corresponding pipe part, and therefore a process at step 232 may move the location of the display of the pressure to a point on the screen closer to the corresponding pipe. In order to achieve this, the various information (temperature, pressure, etc.) may be arranged in priority order, with the highest priority corresponding to a position close to the pipe. Then, if some of the information is masked, information with the next highest priority order is moved to a position closest to the pipe.

3. Screen balance adjustment

When masking is performed, to exclude unnecessary information from the screen, the screen may then become unbalanced because the information then displayed is located in only a part of the total screen. Then, a process 233 may be used to adjust the location of the information on the screen, to make the screen well-balanced. This operation is controlled by the knowledge process component 8.

4. Display of screen requests

As was mentioned above, the user may request that only some of the information is displayed. Then, it is useful for the screen also to contain an indication of the restricted nature of the display, by saying for example that the screen displays only pressure, only displays enthalpy, etc. This may be achieved by a step 234.

5. Special processing

There are a number of further operations that may be carried out. At a further step 235, and this is illustrated in more detail in Fig. 7. The processes may include:

a) multiwindow/multiscreen processing; this involves the use of a multiwindow function of a display device, so that two screens may be displayed on the display device. Examples of such a multiwindow arrangement may include:

i) if screens are ordered in a priority order, one window may show the screen of highest priority order, and another window may show a screen of the next highest priority order.

ii) if a screen which was displayed at a previous time, has been overridden that overridden screen may be shown in a window. For example, when a different screen is automatically displayed, thereby overriding the selection of screen by the user, the window may show the screen that has been overriden.

b) Screen renewing; this involves successively operating a screen renewal operation when the screen has been displayed. For example, suppose an instruction is given to delete one screen and replace it by another screen. Then, the processing may arrange for the first screen to seem gradually to disappear from one side, with the next screen gradually seeming to appear from that side. This process also may permit two sorts of screen to be displayed through a synthetic processing.

c) Symbol display; it is possible for a symbol, such as a pointing finger, or arrow to be displayed on the screen to draw the attention of a user to some specific feature.

Using the system described above with reference to Figs. 1 to 7, the operation of an embodiment of the present invention has been described, and the hard way to achieve this is shown in Fig. 8. That Figure shows:

1) a process input device 30; a device for inputting processed information of a plant or an apparatus system.

2) An arithmatic processing device 33; a device for carrying out the processing operations, editing, arithmatic functions, etc., as discussed with reference to Figs. 1 to 7. This device has the functions of components 2,3,5,7 and 8 in Fig. 1.

3. Picture detecting device 31; this is a device for detecting the existance of an operator and carrying out the function shown by component 9 in Fig. 1.

4) ID card input device 32; this permits ID cards to be input which store information concerning the users of the display device, to enable the display device to adapt to different users. This thus carries out the invention of component 10 in Fig. 1.

5) Screen display device 34; this displays processed and edited screens, and may be an CRT (VDU) a large-sized display, or a similar display, and thus carries out the function of component 4 in Fig. 1.

6) Screen copying device 35; this device permits screens to be copied to a hard-copy, and thus carries out the function of component 11 in Fig.1 .

7) Operator demand input device 36; this permits the user of the display device to input requests, and thus fulfills the function of component 6 in Fig. 1.

8) Information device 37 and indicator 38; these may inform and indicate automatic screen display in order to attract the attention of a user to a particular screen, and thus carry out the function indicated by component 12 in Fig. 1.

By way of comparison, Fig. 9 shows functions carried out by a known control system. This known control system may be compared that of the present invention, shown in Fig. 1, and corresponding components are indicated by the same reference numerals. Thus, in the known system, processes information 1 is read periodically, and combined with fixed form screen information 2 prepared in advance. The prepared screen is then displayed on a display device 4. Screens may be selected automatically, particularly if a change is detected in the plant or apparatus being controlled, as shown at component 5, and also screens can be changed in accordance with a request from a user of the display device, shown by component 6. The screen can also be copied using a display screen copying component 11.

Specific examples of screens producible by the present invention will now be described with reference to Fig. 10 to 25.

Fig. 10 shows graphically a plant being a piping system, in which various processes are displayed. In Fig. 10, the plant is a steam power plant, and the screen shows a steam turbine gland seal and the vacuum system of the plant. In this screen, there is shown graphically apparatus such as a high pressure turbine (HP TB), a low pressure turbine (LP TB), a vacuum pump (VACP), and piping for steam, water, air etc. The connection of these apparatuses is displayed graphically, and the operational state of these apparatuses is displayed. Also displayed is fluid flowing in the pipes. The existance of fluid flow is displayed by a display with a different colour, and the operational states of the system are displayed digitally. Thus, the operational conditions of the system is displayed to a user of the display device.

As illustrated in Fig. 10, the screen also shows some process conditions displayed by a bar-graph at the right hand side of the screen. Then, the present invention is applied to the screen shown in Fig. 10, to delete the process states with a zero

value, since these present no information to the user. Masking is carried out on such information, and the result is the screen shown in Fig. 11.

For example, when an input device such a touch panel is used, a touch area for indicating processing and editing of the display screen may be provided at a particular area of the screen e.g. the bottom of the screen as shown in Fig. 10. In this case, when it is intended to mask zero values, this may be achieved by touching an area of that touch panel marked "zero value mask" and this causes information with a zero value to be deleted from the screen.

Fig. 12 illustrates a screen corresponding to a low pressure clean-up system. With the screen, if a request is input that information concerning apparatuses which are stopped is deleted from the screen, and only those apparatuses which are working are displayed, the apparatuses which are not working may be masked, and the result is shown by the screen in Fig. 13. This screen is much more clear.

Fig. 14 shows a screen representing a turbine steam/drain piping system. If the user of the display device requests for this screen to be displayed showing only the temperatures of the various processes being carried out, masking of specific areas shown in Fig. 15 by diagonal lines may occurr, and the result is a simplified screen as shown in Fig. 16.

Fig. 17 is a screen showing a power source system. If a user requests that only voltage values of this screen can be displayed, areas may be masked as shown by diagonal lines in Fig. 18, thereby simplifying the screen. Those masked parts will be deleted from the final screen in a similar way to that shown in Fig. 16.

Fig. 19 illustrates graphically a specific display method for adjusting the processes information display area, as referred to above. Information is displayed in a priority order, and when information with a higher priority is considered by the user to be unnecessary, information displayed in the next priority order may be moved upwardly, to display the desired information with highest priority uppermost.

Fig. 20 illustrates in more detail an example of an animated masking process, discussed above with reference to Fig. 6 in which the attention of the user is attracted by flickering of part or all of the display. In a similar way, Fig. 21 shows a specific example of an enlarging operation. This was referred to above with reference to Fig. 1, and ensures that desired information is enlarged on the display to give it a higher visibility.

Figs. 22 to 25 illustrate a specific example of a screen balance adjustment process, referred to with reference to Fig. 5. In Fig. 22, there is shown the operation of masking part of a screen, to display only the desired information. The result is an unbalanced screen in which information is concentrated at the upper left side of the screen. In order to adjust this inbalance, information relating to the position of the information on the screen must be determined, and this is shown with reference to Fig. 23. Thus, when values a_1, d_1, determine the position of the information on the screen, areas A, B,C,D, which are hatched in Fig. 23 (a) should be made as uniform as possible. To do this, the operation shown in 23(b) can be carried out so that the position of the information on the screen may be moved according to those rules. This operation can be carried out by conventional conversion calculations, and the operational speed of this can be improved by use of "fuzzy reasoning". The result of this is shown in Fig. 23(c) in which the information is centralised on the screen. it may also be appreciated that the information displayed may then be enlarged to fill the screen, using the enlarging function discussed above.

A practical example of this is shown by Figs. 24 and 25, which information is masked on the right hand side of the screen in Fig. 24, and then the information of the screen is shifted as shown in Fig. 25, so that it is centralised on the screen.

Thus, according to the present invention, fixed form screen information prepared in advance may be processed so that information which does not need to be displayed may be made visually less prominent by operations such as maksing, and information desired to be displayed may be made more prominent. Furthermore, information may be added to the display and the balance of the screen of the display may be adjusted. Thus, the desired information may be displayed on a display device in a clear way, so that the user of the display device can clearly see genuinely necessary information, without being troubled by excess information, but at the same time without causing problems due to misunderstanding of the display information. The present invention also ensures that unnecessary information is not displayed, so that the user does not need to trouble himself with that unnecessary information.

Claims

1. A control system for an industrial plant which is arranged to generate a plurality of prepared displays, each comprising at least one graphical pattern representing the plant and at least some plant data representing operating parameters of the plant; there being means for selecting one of the prepared displays;
characterised in that:

the control system includes means (3,8) for modifying said selected one of said prepared displays to generate a modified display, and means (4) for displaying said modified display.

2. A control system according to claim 1 wherein the means (3,8) for modifying the selected one of the prepared displays is arranged to be operable in response to a request from an operator.

3. A control system for an industrial plant which is arranged to generate a plurality of prepared displays, each comprising at least one graphical pattern representing the plant and at least some plant data representing operating parameters of the plant; there being means for selecting one of the prepared displays;
characterised in that:
the control system includes means (3,8) for selecting only some of said plant data, and means for (4) displaying said selected one of said prepared displays as a display in which said selected plant data of said selected one of said prepared displays are visually distinguished from other plant data of said selected one of said prepared displays.

4. A control system according to claim 2, wherein the means (3,8) for selecting only some of the plant data is operable in response to a request from an operator, thereby to permit the operator to select which of the plant data is to be visually distinguished when displayed by the display means (4).

5. A control system according to claim 3 or claim 4, having modifying means for modifying the prepared displays to generate the selected display.

6. A control system according to any one of the preceding claims wherein the modifying means is arranged to carry out at least one modification operation selected from the group consisting of deletion, translation, change of intensity, change of colour, magnification and periodic changing of at least a part of said selected one of said prepared displays.

7. A control system according to any one of the preceding claims including means for calculating further plant data representing further operating conditions of said plant from said plant data, and said means for generating a plurality of prepared displays is arranged to incorporate said further plant data on said selected one of prepared displays in the generation of said modified display.

8. A control system according to any one of the preceding claims having printing means for providing a hard-copy print of said modified display.

9. A control system according to any one of the preceding claims having printing means for providing a hard-copy print of the selected prepared display.

10. A control means according to claim 8 or claim 9, wherein said printing means is arranged to be activated by a user.

11. A control system according to any one of claims 8 to 10, wherein said printing means is arranged to be activated automatically.

12. A control system according to any one of the preceding claims having means for inputting information relating to the status of a user, and said means for modifying said selected one of said prepared displays is arranged to act in dependence on said information, whereby said modified display is determined by the status of the user.

13. A control system according to any one of the preceding claims, further including means for selecting a further one of said prepared displays;
means for modifying said further one of said prepared displays to generate a further modified display;
and
said means for displaying said modifying display is arranged to display said modified display and said further modified display simultaneously.

14. An industrial plant having a control system according to any one of the preceding claims.

15. An industrial plant according to claim 14 having detectors for detecting the operational parameters of the plant, and converting those operational parameters to plant data means for transmitting those plant data to the control system.

16. A method of operating an industrial plant in which a plurality of prepared displays are generated, each comprising at least one graphical pattern representing the plant and at least some plant data representing operating parameters of the plant, and one of the prepared displays is selected;
characterised in that:
the selected one of the prepared displays is modified and the modified display is displayed.

17. A method according to claim 16, wherein, said modifying of said selected one of saidprepared displays is in response to a request from a user.

18. A method according to claim 16 or claim 17, wherein said step of modifying said selected one of said prepared displays includes at least one of deletion, translation, change on intensity, change of colour, magnification, and periodically changing at least part of said selected one of said prepared displays.

19. A method according to any one of claims 16 to 19 further including the step of calculating further plant data representing further operational parameters of said plant from said plant data, and incorporating said further plant data in said modified display.

20. A method of operating an industrial plant in which a plurality of prepared displays are generated, each comprising at least one graphical pattern representing the plant and at least some plant

data representing operating parameters of the plant, and one of the prepared displays is selected; characterised in that:
the method further includes selecting only some of the plant data and displaying the selected one of the prepared displays in which the selected plant data of the selected are of the preepared displays are visually distinguished from other plant data of the selected one of the prepared displays.

21. A method according to claim 19 wherein said said selecting of only some of said plant data is in response to a request from a user.

22. A display device for a control system, comprising:
means for generating a plurality of prepared displays, each of the prepared displays comprising a graphical pattern, and a plurality of data; and
means for selecting one of the displays;
characterised in that:
the display device further includes means (3,8) for modifying the selected one of the prepared displays to generate a modified display; and means (4) for displaying the modified display.

23. A display device for a control system, comprising:
means for generating a plurality of prepared displays, each of the prepared displays comprising a graphical pattern, and a plurality of data; and
means for selecting one of the displays;
characterised in that:
the display device includes means (3,8) for selecting only some of the plant data, and means (4) for displaying the selected one of the prepared displays as a display in which the selected plant data are visually distinguished from other plant data.

FIG. 1

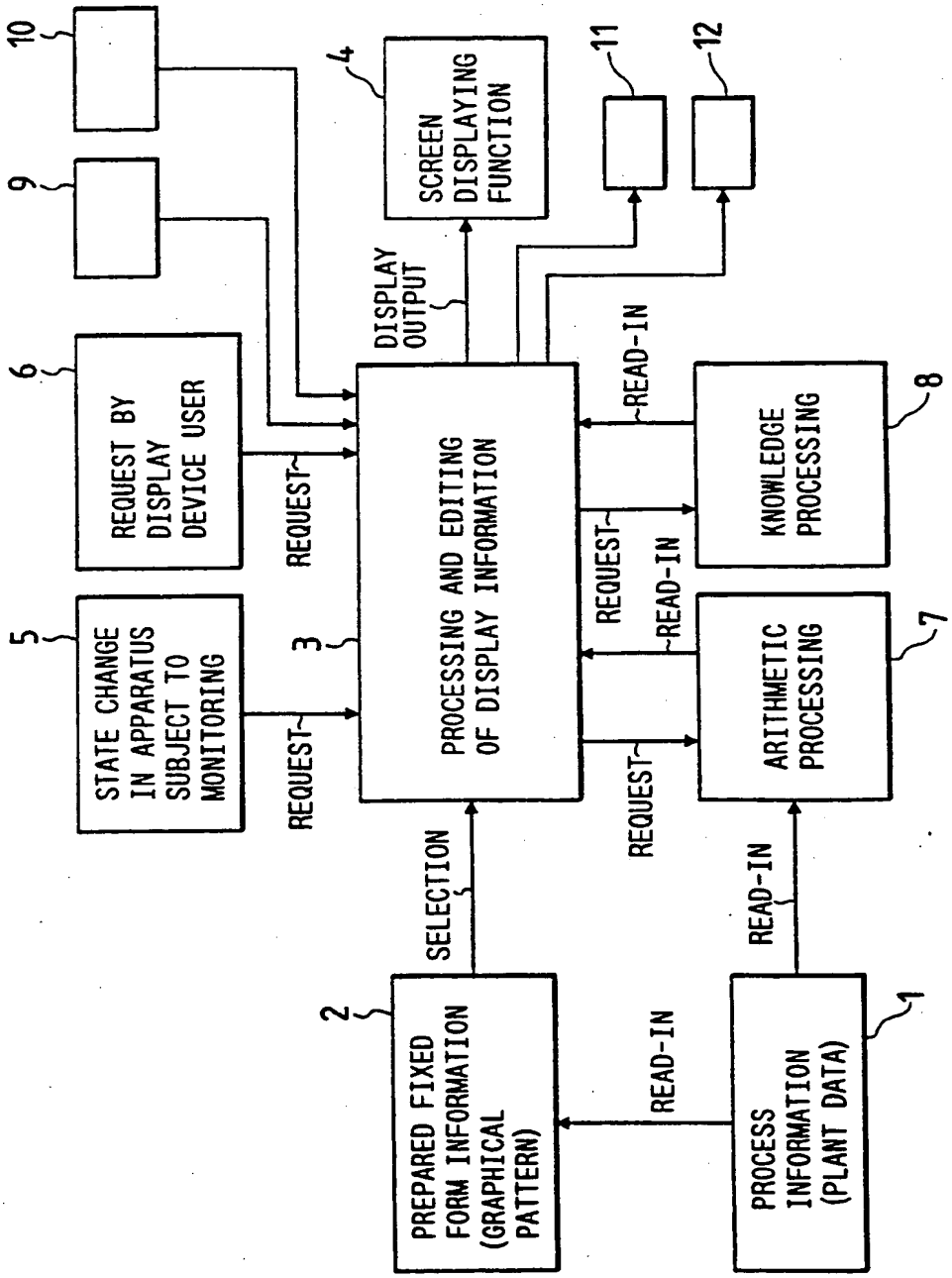

10
9
6
REQUEST BY DISPLAY DEVICE USER
5
STATE CHANGE IN APPARATUS SUBJECT TO MONITORING
REQUEST
REQUEST
3
4
SCREEN DISPLAYING FUNCTION
DISPLAY OUTPUT
PROCESSING AND EDITING OF DISPLAY INFORMATION
11
12
READ-IN
READ-IN
REQUEST
READ-IN
KNOWLEDGE PROCESSING
8
ARITHMETIC PROCESSING
7
REQUEST
SELECTION
READ-IN
2
PREPARED FIXED FORM INFORMATION (GRAPHICAL PATTERN)
READ-IN
PROCESS INFORMATION (PLANT DATA)
1

FIG. 2

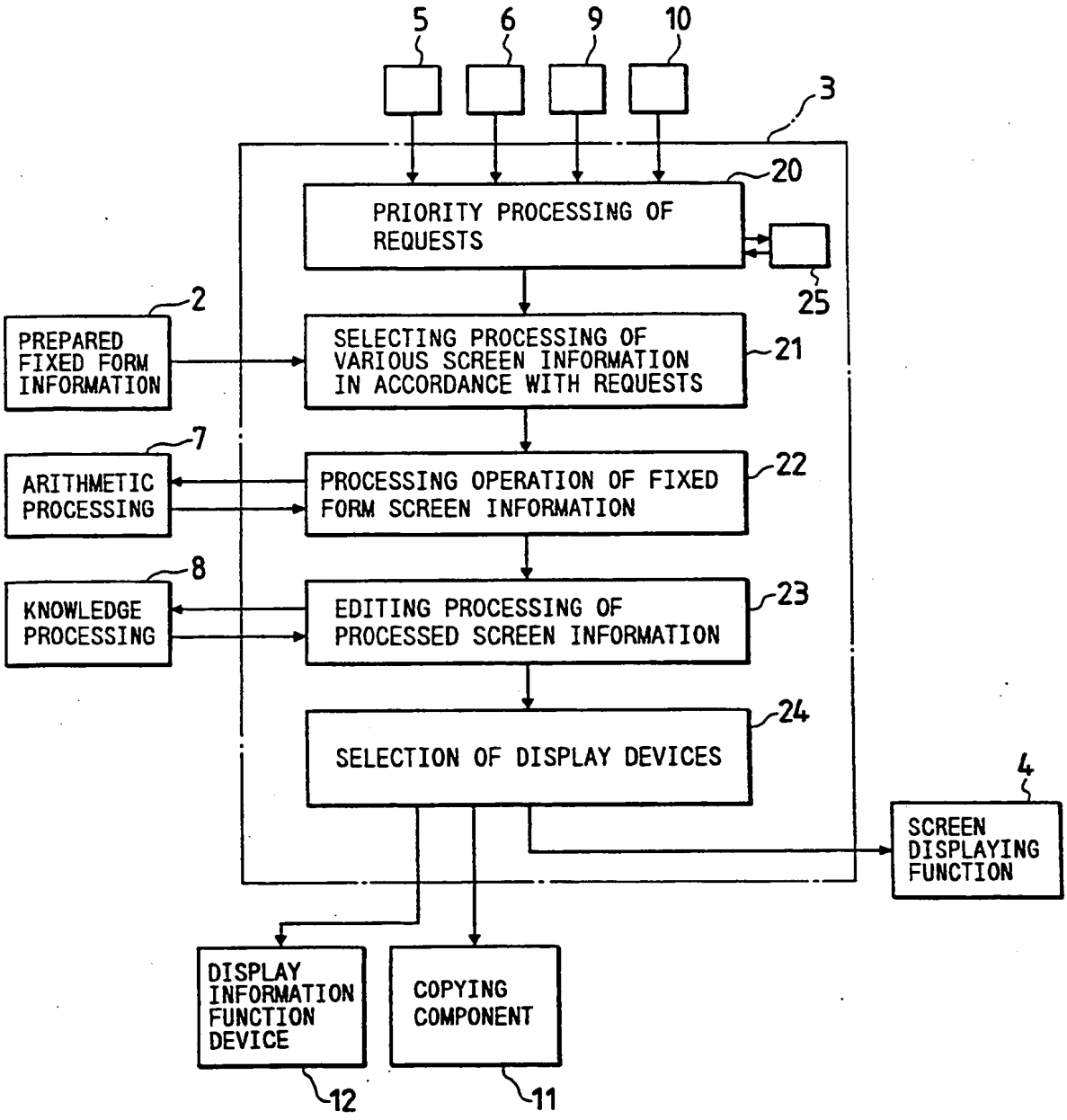

5
6
9
10
3
20
PRIORITY PROCESSING OF REQUESTS
25
2
PREPARED FIXED FORM INFORMATION
SELECTING PROCESSING OF VARIOUS SCREEN INFORMATION IN ACCORDANCE WITH REQUESTS
21
7
ARITHMETIC PROCESSING
PROCESSING OPERATION OF FIXED FORM SCREEN INFORMATION
22
8
KNOWLEDGE PROCESSING
EDITING PROCESSING OF PROCESSED SCREEN INFORMATION
23
SELECTION OF DISPLAY DEVICES
24
4
SCREEN DISPLAYING FUNCTION
DISPLAY INFORMATION FUNCTION DEVICE
12
COPYING COMPONENT
11

FIG. 3

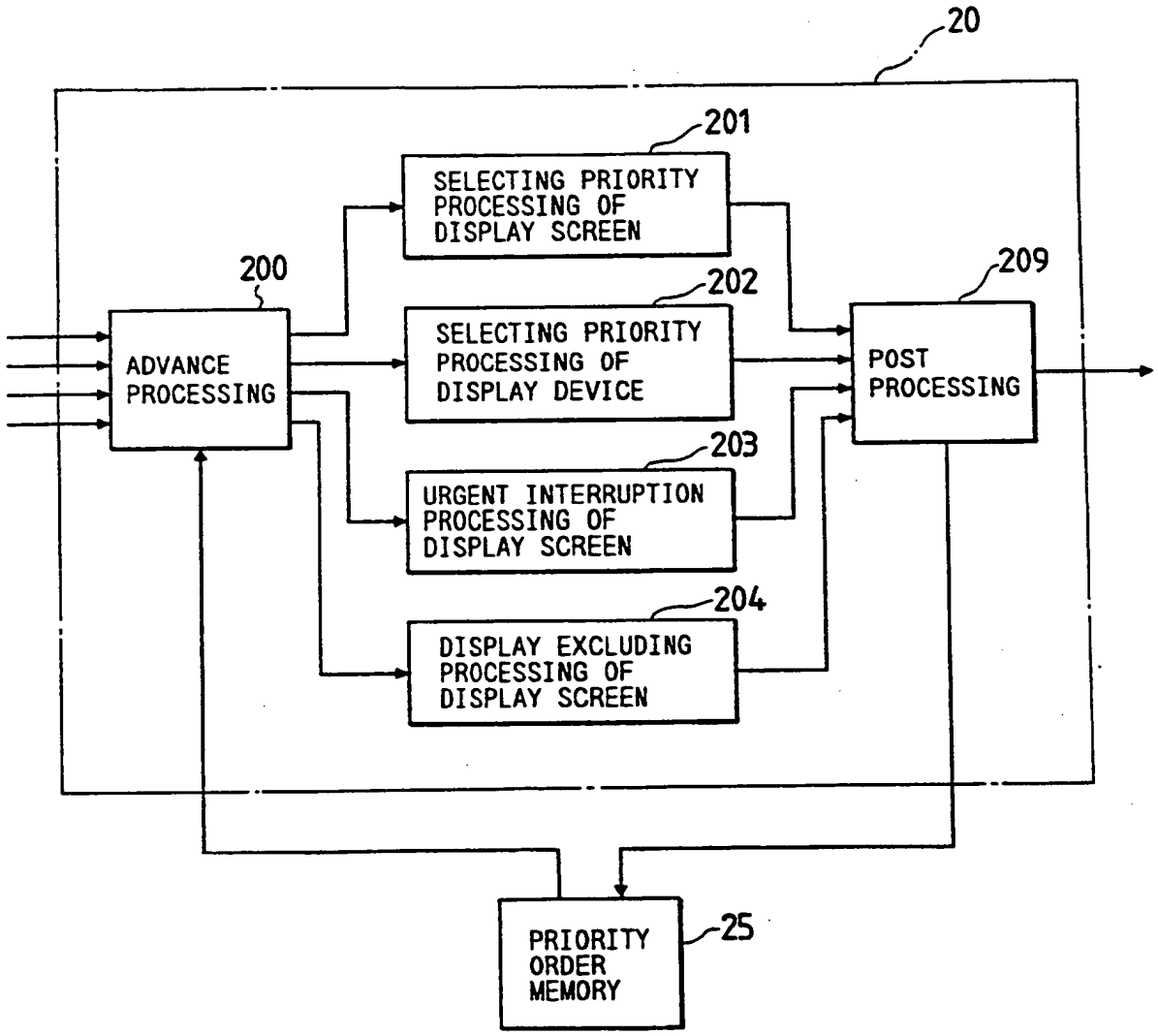

20
201
SELECTING PRIORITY PROCESSING OF DISPLAY SCREEN
200
202
209
ADVANCE PROCESSING
SELECTING PRIORITY PROCESSING OF DISPLAY DEVICE
POST PROCESSING
203
URGENT INTERRUPTION PROCESSING OF DISPLAY SCREEN
204
DISPLAY EXCLUDING PROCESSING OF DISPLAY SCREEN
PRIORITY ORDER MEMORY
25

FIG. 4

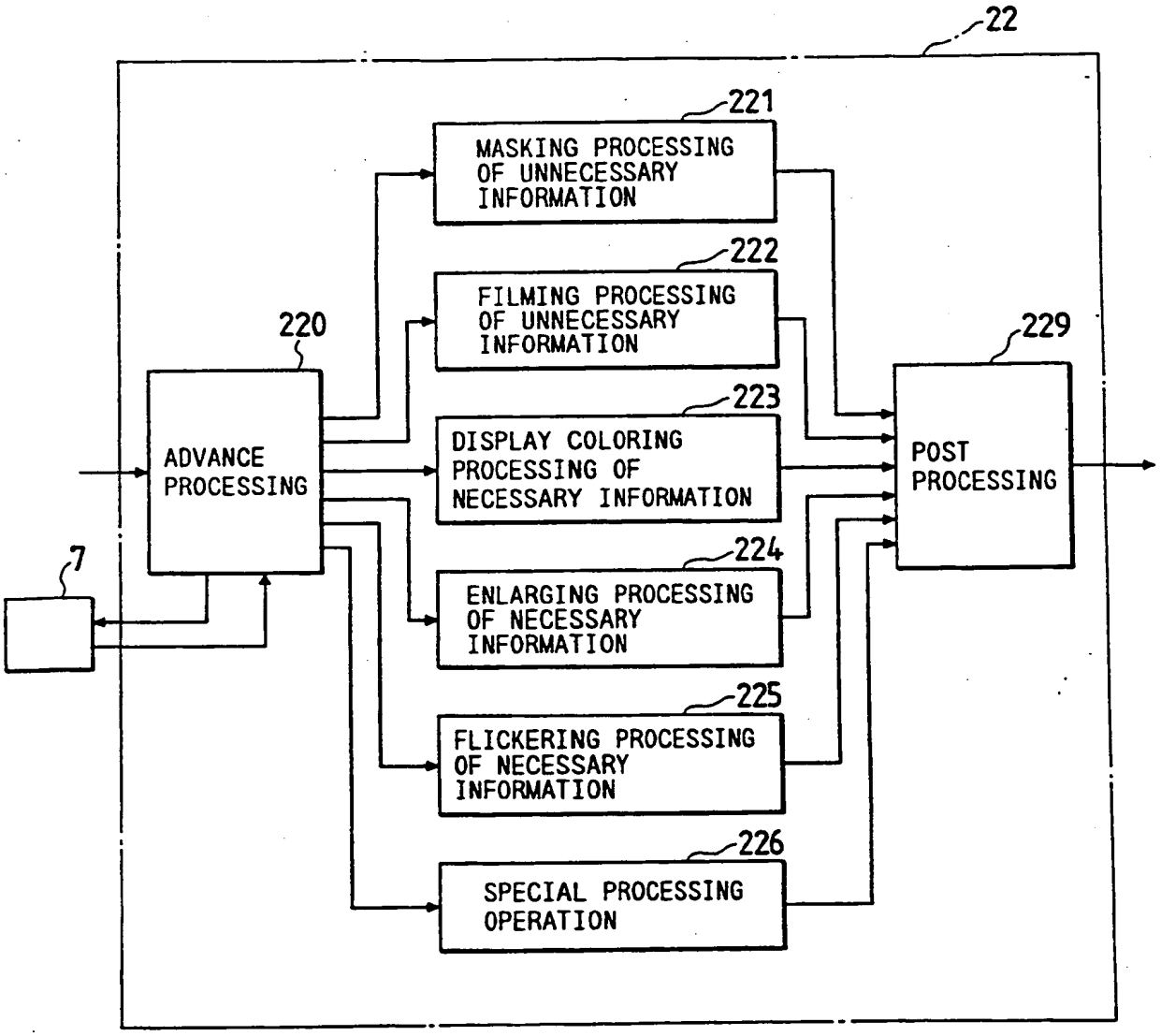


FIG. 5

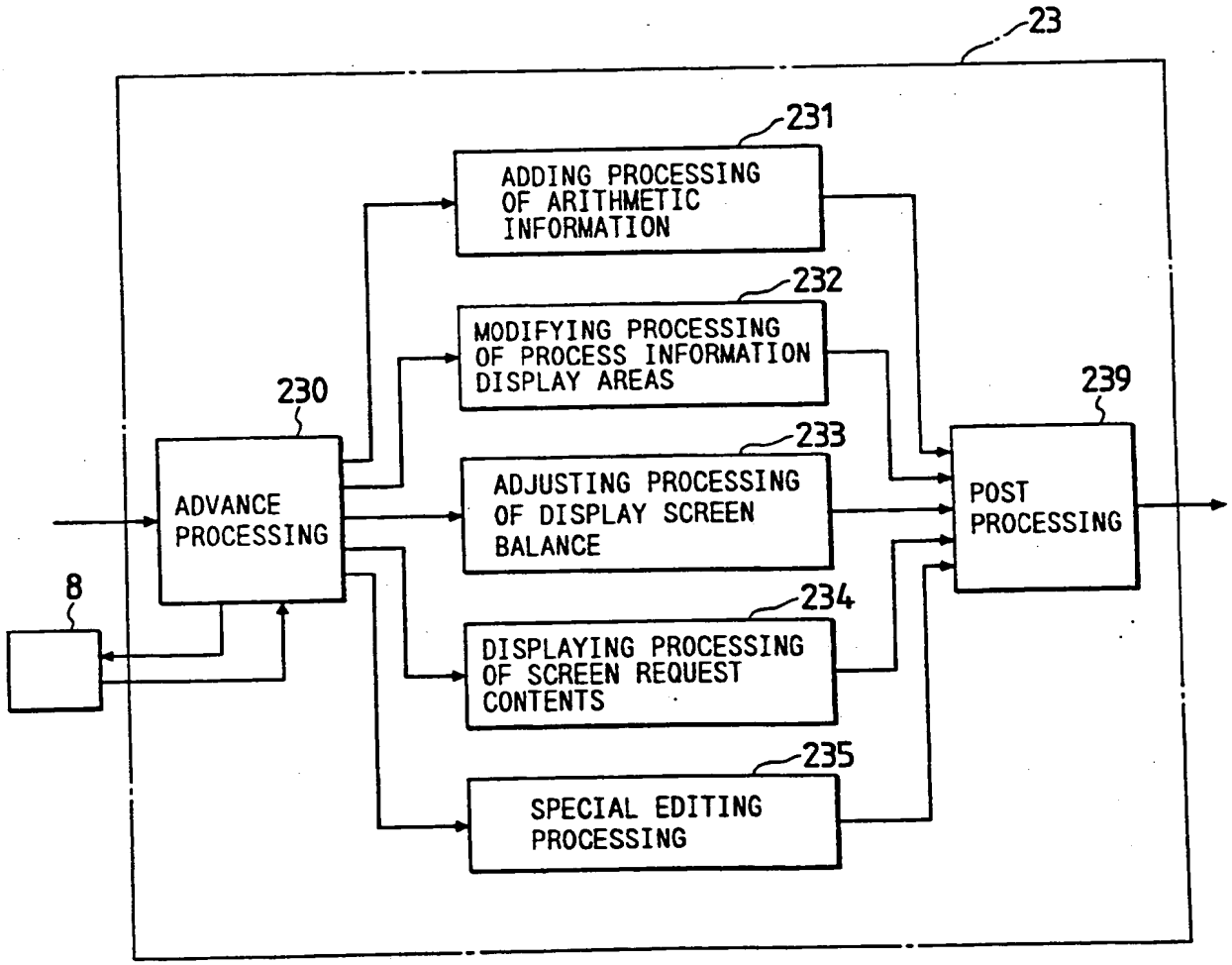


FIG. 6

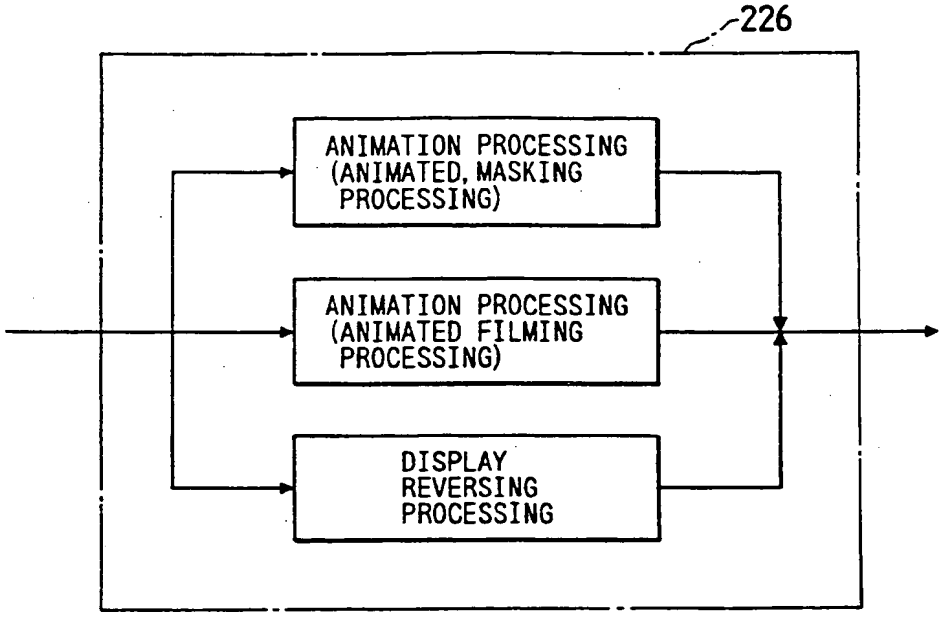

226
ANIMATION PROCESSING (ANIMATED, MASKING PROCESSING)
ANIMATION PROCESSING (ANIMATED FILMING PROCESSING)
DISPLAY REVERSING PROCESSING

FIG. 7

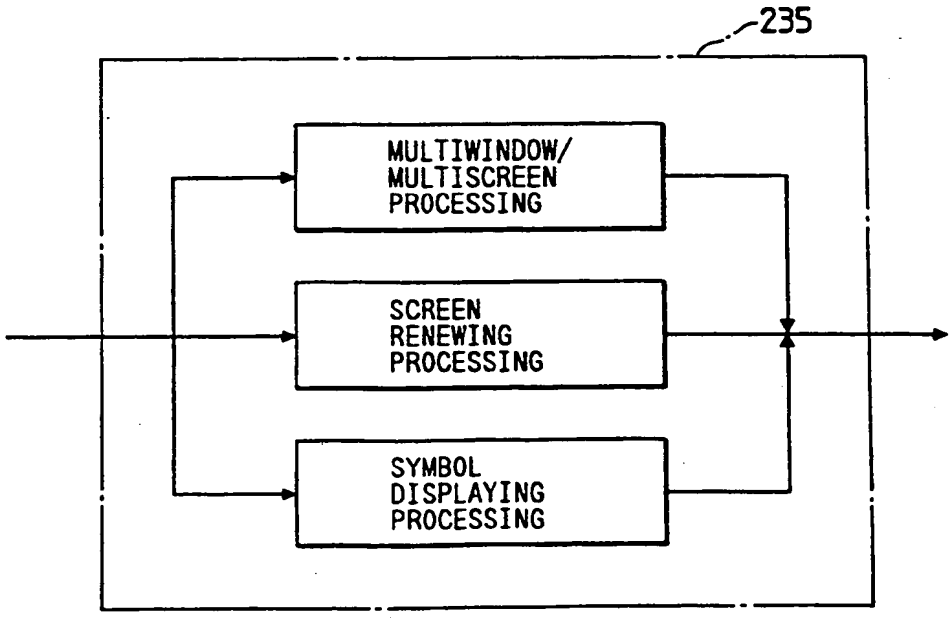

235
MULTIWINDOW/ MULTISCREEN PROCESSING
SCREEN RENEWING PROCESSING
SYMBOL DISPLAYING PROCESSING

FIG. 8

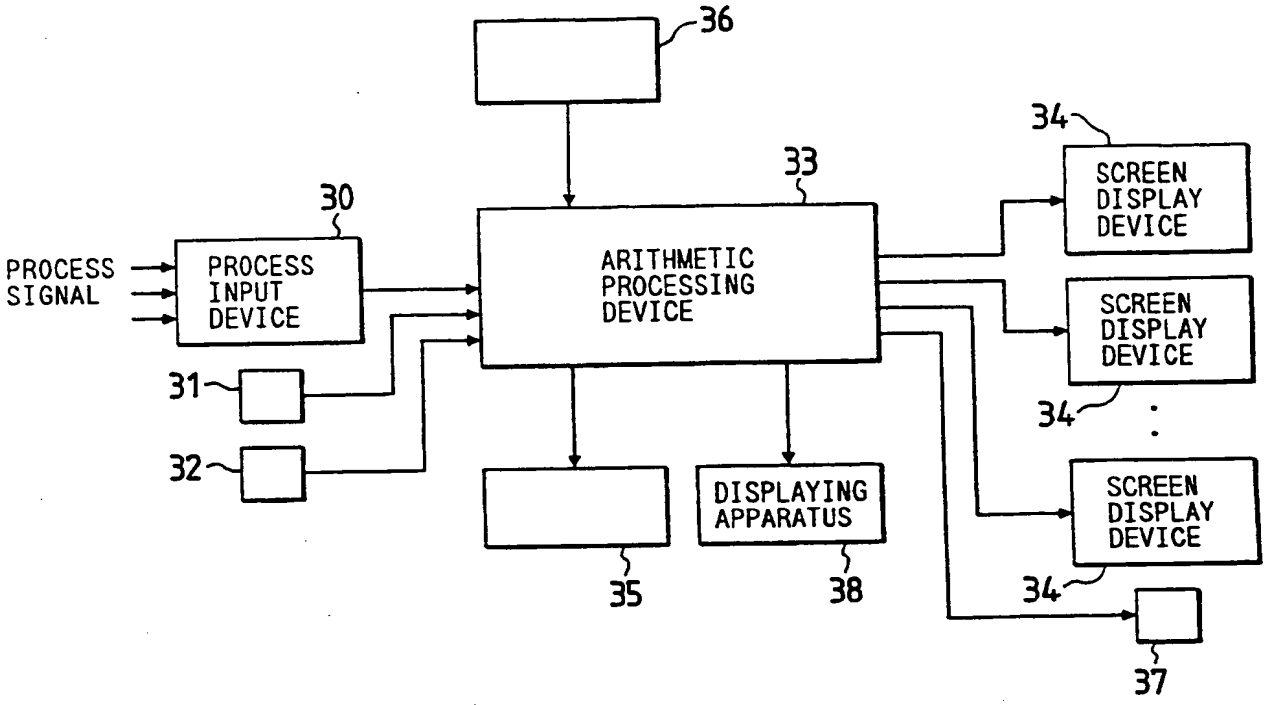

36
34
33
SCREEN DISPLAY DEVICE
30
PROCESS SIGNAL
PROCESS INPUT DEVICE
ARITHMETIC PROCESSING DEVICE
SCREEN DISPLAY DEVICE
31
34
32
SCREEN DISPLAY DEVICE
DISPLAYING APPARATUS
34
35
38
37

FIG. 9

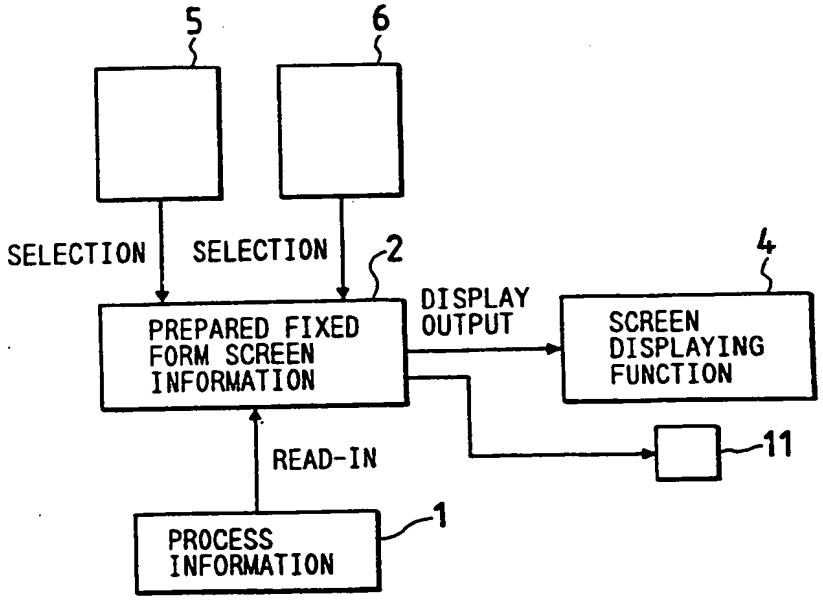

5
6
SELECTION
SELECTION
2
4
DISPLAY OUTPUT
PREPARED FIXED FORM SCREEN INFORMATION
SCREEN DISPLAYING FUNCTION
11
READ-IN
PROCESS INFORMATION
1

FIG. 10

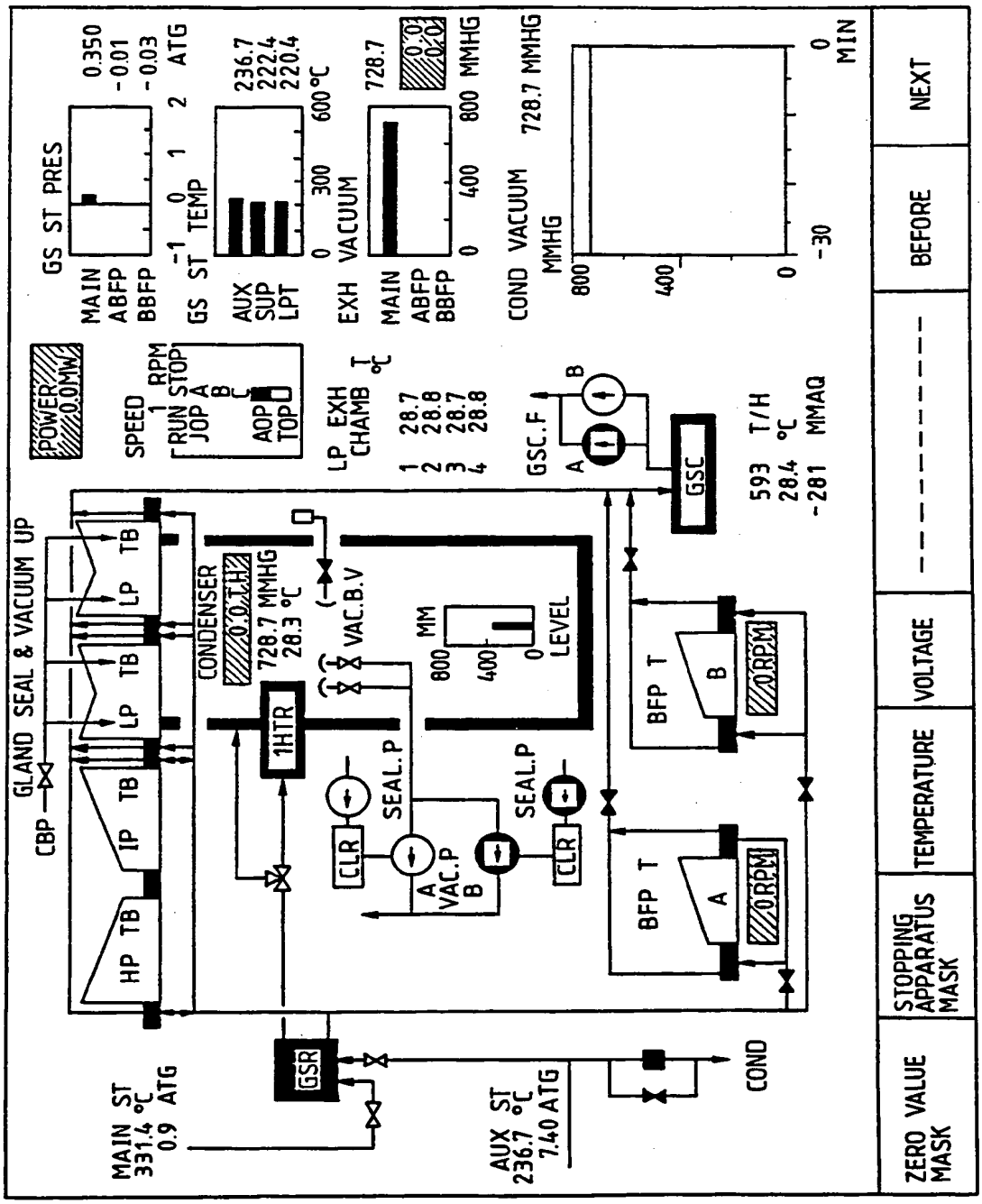


FIG. 11

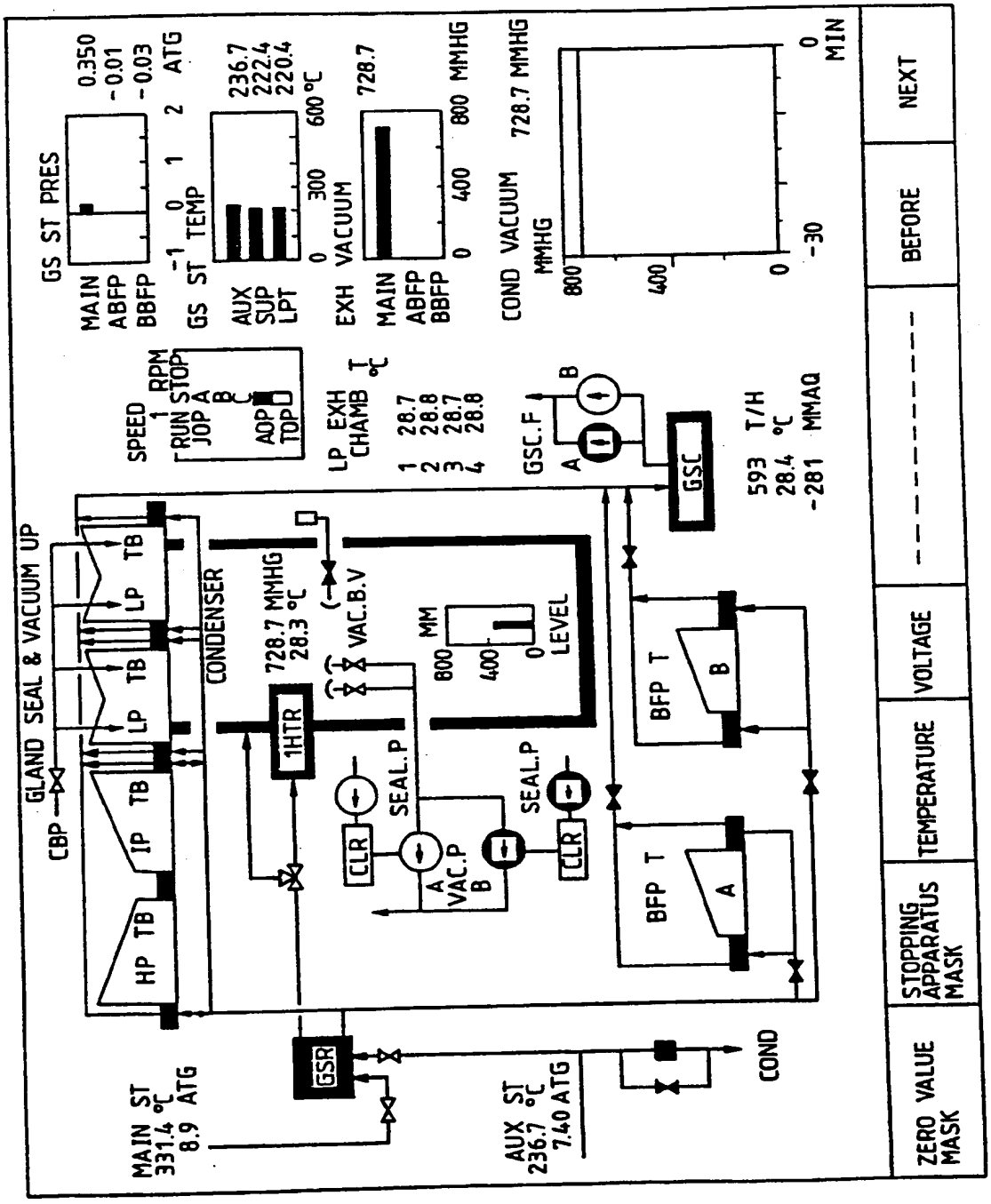


FIG. 12

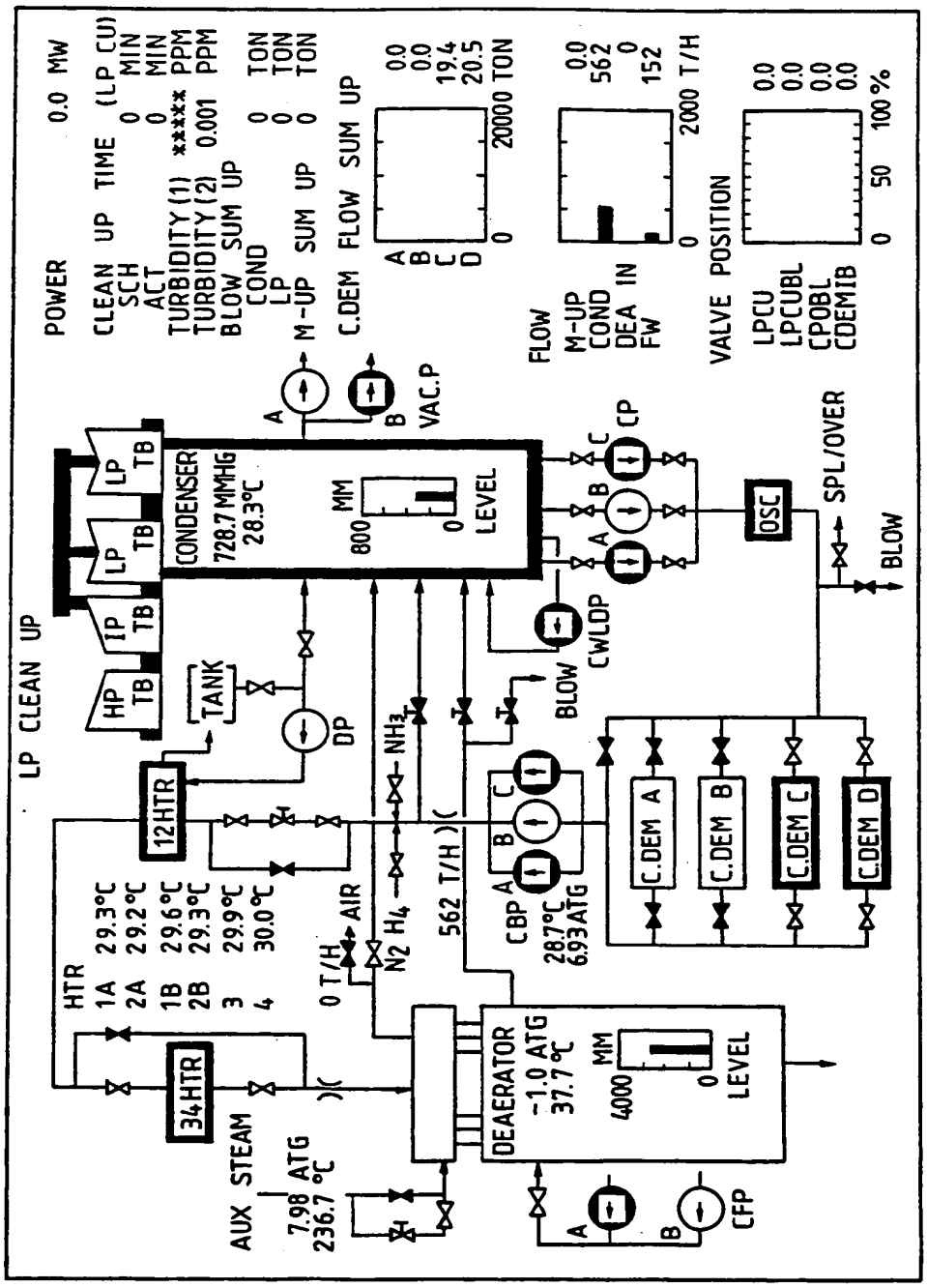

LP CLEAN UP
POWER 0.0 MW
CLEAN UP TIME (LP CU)
SCH 0 MIN
ACT 0 MIN
TURBIDITY(1) ***** PPM
TURBIDITY(2) 0.001 PPM
BLOW SUM UP
COND 0 TON
LP 0 TON
M-UP SUM UP 0 TON
C.DEM FLOW SUM UP
A 0.0
B 0.0
C 19.4
D 20.5
0 20000 TON
FLOW
M-UP 0.0
COND 562
DEA IN 0
FW 152
0 2000 T/H
VALVE POSITION
LPCU 0.0
LPCUBL 0.0
CPOBL 0.0
CDEMIB 0.0
0 50 100 %
A VAC.P B
LP TB
LP TB
IP TB
HP TB
CONDENSER
728.7 MMHG
28.3°C
MM
800
0
LEVEL
TANK
DP
12HTR
34HTR
HTR
1A 29.3°C
2A 29.2°C
1B 29.6°C
2B 29.3°C
3 29.9°C
4 30.0°C
AUX STEAM
7.98 ATG
236.7 °C
0 T/H
AIR
N2 H4
NH3
562 T/H
CBP
28.7°C
6.93ATG
A B C
BLOW
CWLOP
CP
OSC
SPL/OVER
BLOW
C.DEM A
C.DEM B
C.DEM C
C.DEM D
DEAERATOR
-1.0 ATG
37.7 °C
MM
4000
0
LEVEL
A B CFP

FIG. 13

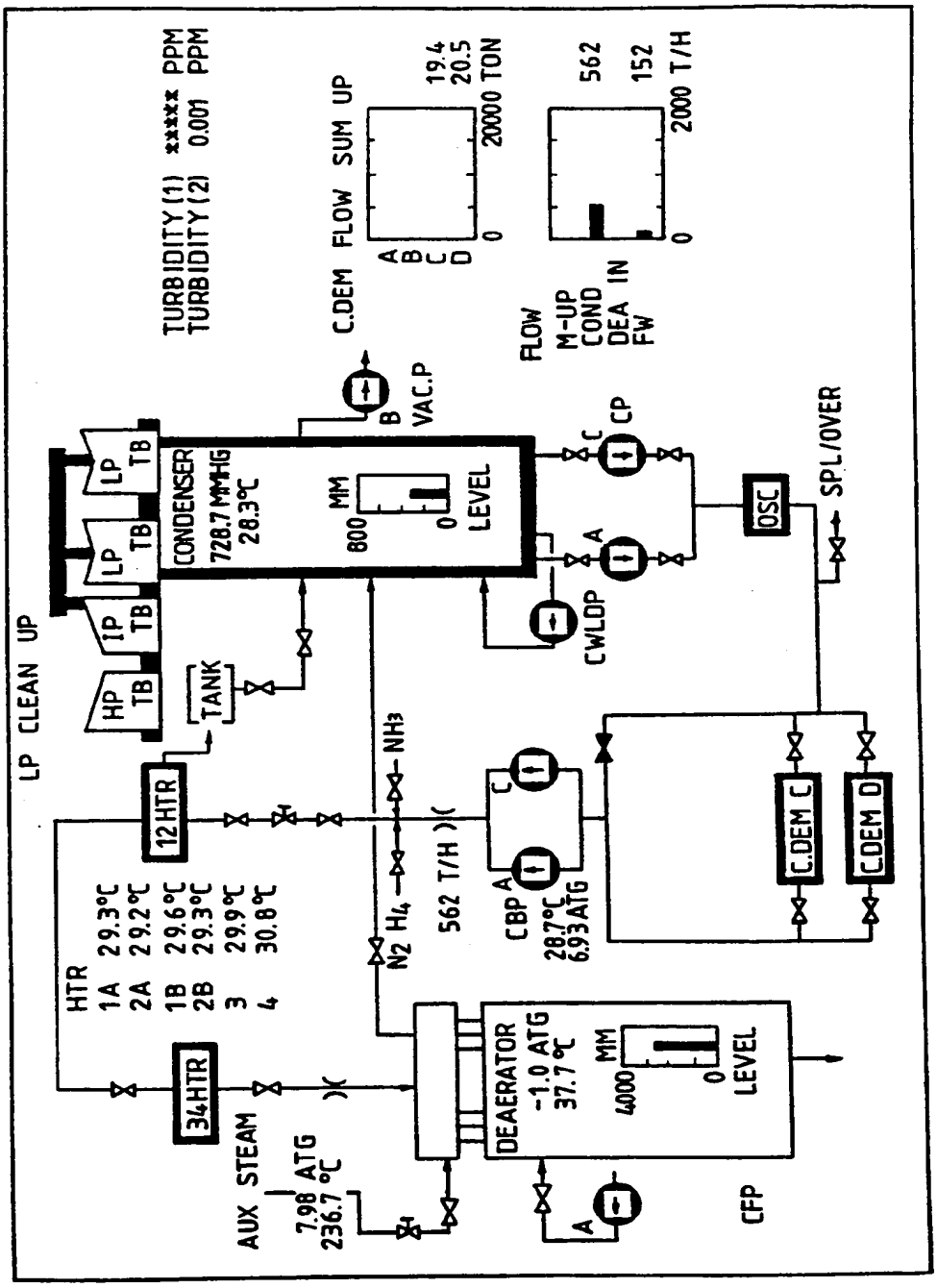

TURBIDITY(1) ***** PPM
TURBIDITY(2) 0.001 PPM
C.DEM FLOW SUM UP
A
B
C
D
0
20000 TON
19.4
20.5
FLOW
M-UP
COND
DEA IN
FW
562
152
0
2000 T/H
LP CLEAN UP
LP
TB
IP
HP
CONDENSER
728.7 MMHG
28.3℃
MM
800
0
LEVEL
B
VAC.P
C
CP
A
CWLOP
OSC
SPL/OVER
TANK
12HTR
NH3
HTR
1A 29.3℃
2A 29.2℃
1B 29.6℃
2B 29.3℃
3 29.9℃
4 30.8℃
N2 H4
562 T/H
CBP
28.7℃
6.93ATG
C.DEM C
C.DEM D
34HTR
AUX STEAM
7.98 ATG
236.7 ℃
DEAERATOR
-1.0 ATG
37.7℃
4000
CFP

FIG. 14

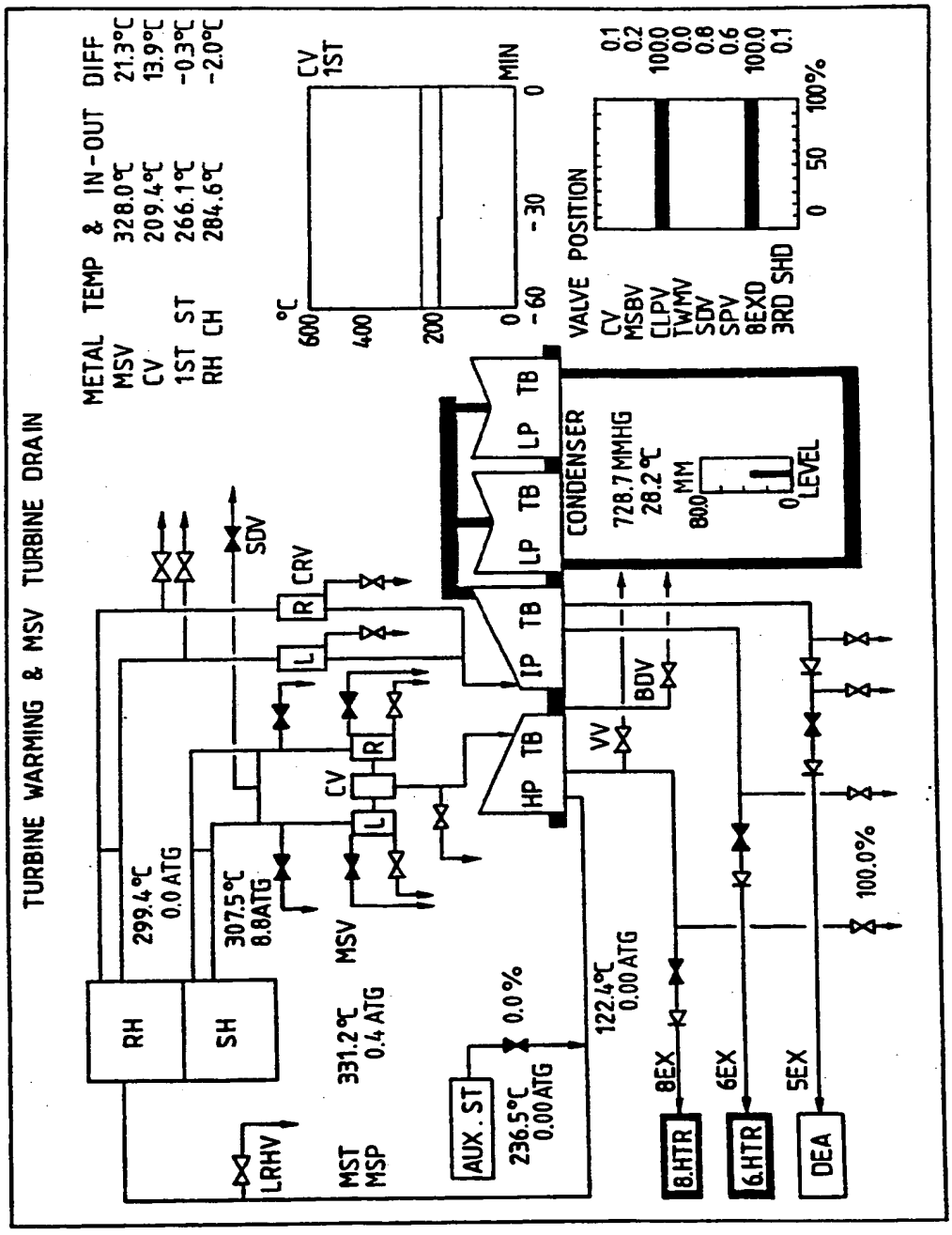


FIG. 15

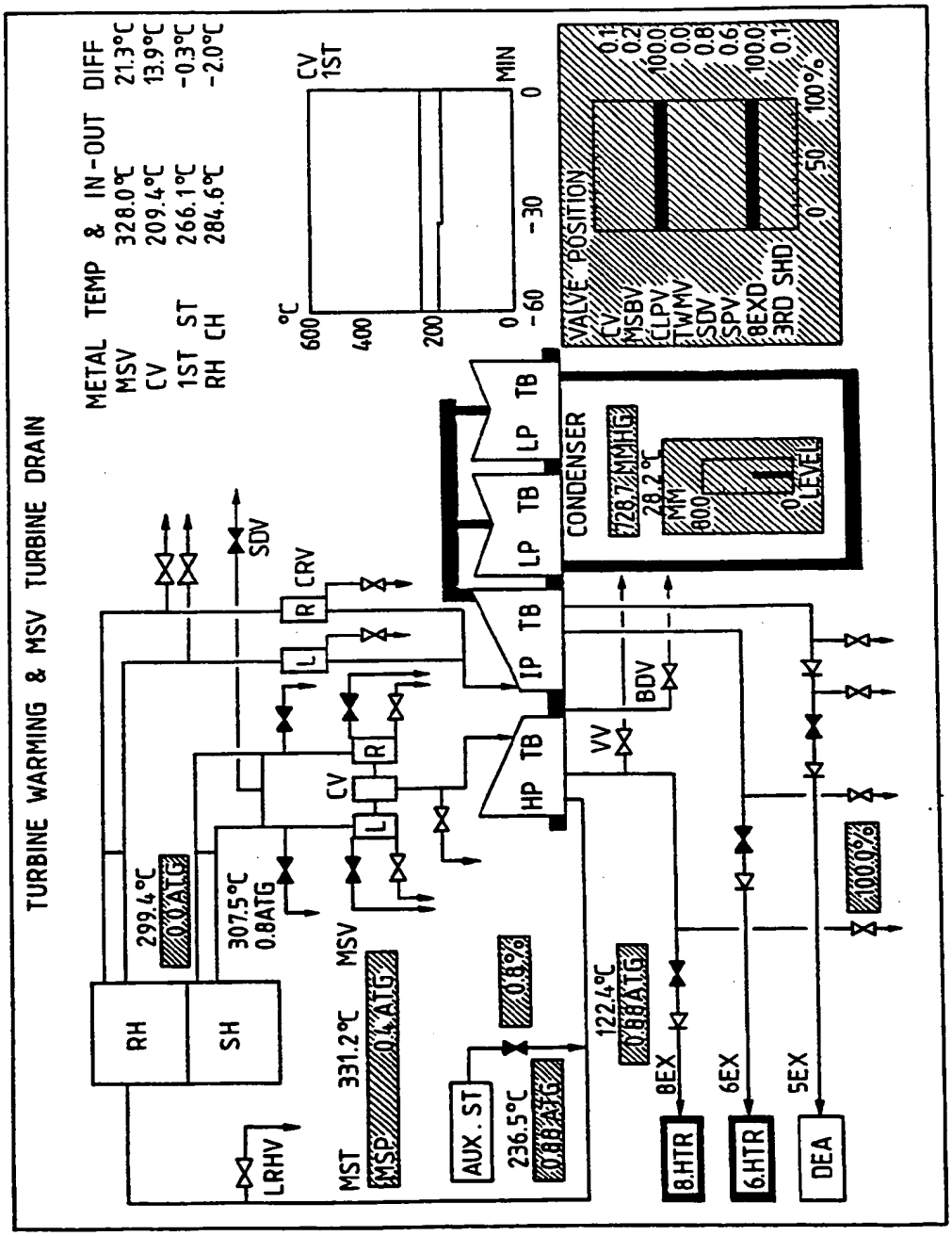

TURBINE WARMING & MSV TURBINE DRAIN
METAL TEMP & IN-OUT DIFF
MSV 328.0℃ 21.3℃
CV 209.4℃ 13.9℃
1ST ST 266.1℃ -0.3℃
RH CH 284.6℃ -2.0℃
CV 1ST
℃
600
400
200
0
MIN
0
-30
-60
VALVE POSITION
CV 0.1
MSBV 0.2
CLPV 100.0
TWMV 0.0
SDV 0.8
SPV 0.6
8EXD 100.0
3RD SHD 0.1
0 50 100%
LP TB
LP TB
IP TB
HP TB
CONDENSER
28.7MMHG
28.2℃
MM
60.0
LEVEL
SDV
CRV
R
L
CV
BDV
VV
RH
SH
299.4℃
0.0ATG
307.5℃
0.8ATG
MSV
331.2℃
0.4ATG
MST
MSP
0.8%
AUX. ST
236.5℃
0.8ATG
122.4℃
0.8ATG
LRHV
8EX
6EX
5EX
100.0%
8.HTR
6.HTR
DEA

FIG. 16

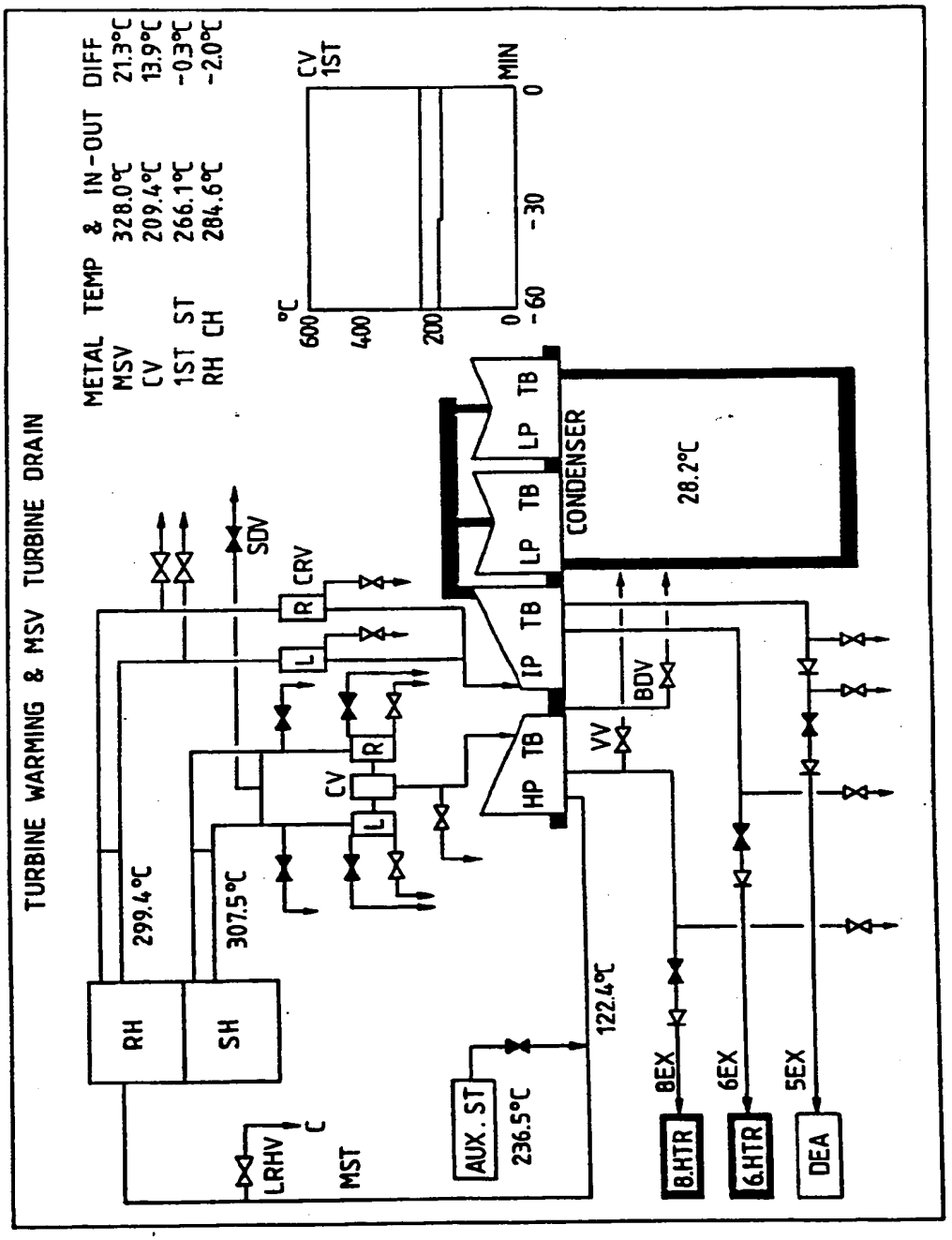

TURBINE WARMING & MSV TURBINE DRAIN
METAL TEMP & IN-OUT DIFF
MSV 328.0℃ 21.3℃
CV 209.4℃ 13.9℃
1ST ST 266.1℃ -0.3℃
RH CH 284.6℃ -2.0℃
CV 1ST
MIN
℃
600
400
200
0
0
-30
-60
SDV
CRV
R
L
CV
IP TB
LP TB
LP TB
HP TB
CONDENSER
28.2℃
BDV
VV
299.4℃
307.5℃
RH
SH
LRHV
MST
AUX. ST
236.5℃
122.4℃
8EX
6EX
5EX
8.HTR
6.HTR
DEA

FIG. 17

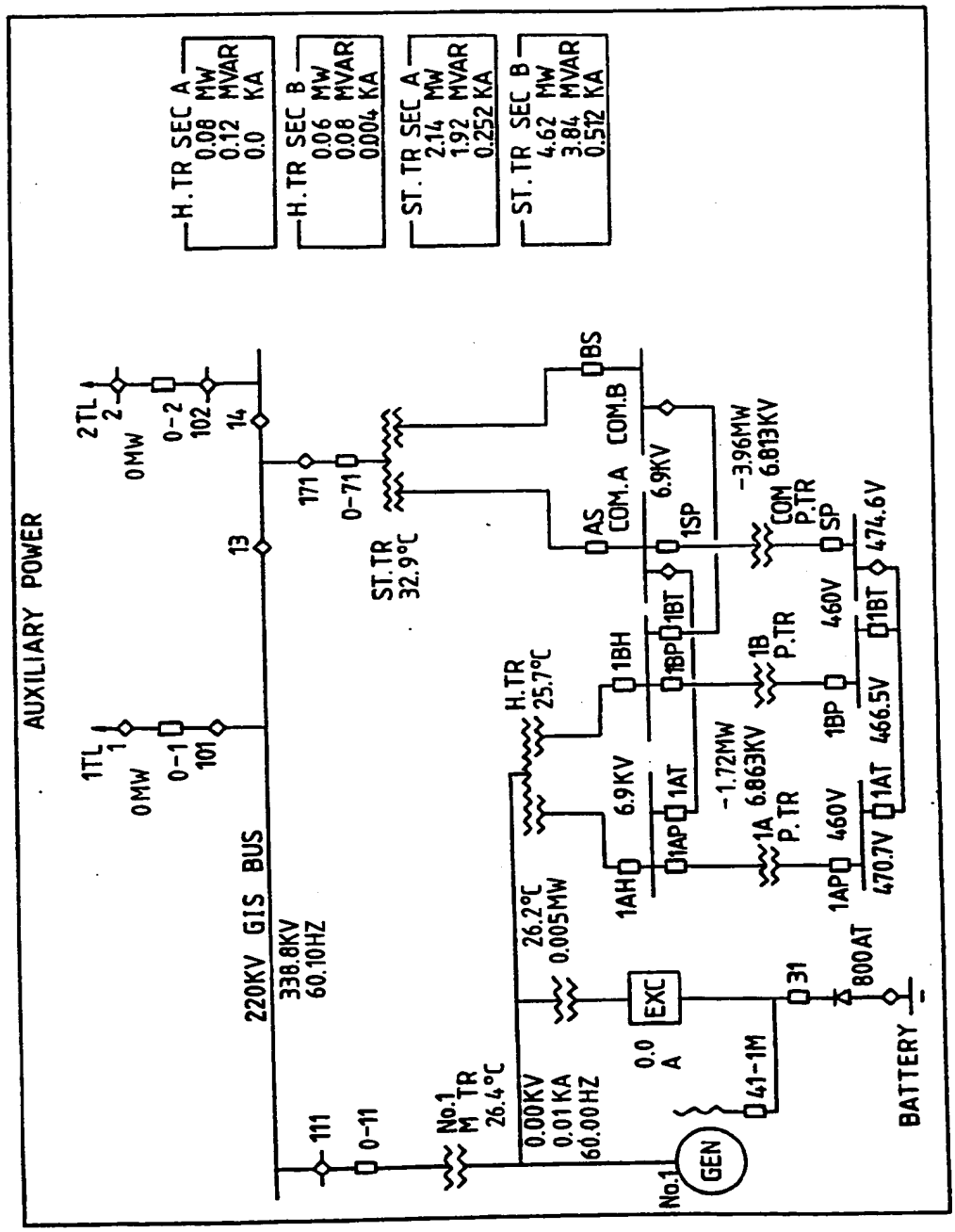

H.TR SEC A
0.08 MW
0.12 MVAR
0.0 KA
H.TR SEC B
0.06 MW
0.08 MVAR
0.004 KA
ST.TR SEC A
2.14 MW
1.92 MVAR
0.252 KA
ST.TR SEC B
4.62 MW
3.84 MVAR
0.512 KA
AUXILIARY POWER
220KV GIS BUS
338.8KV
60.10HZ
1TL
1
0MW
0-1
101
2TL
2
0MW
0-2
102
14
13
171
0-71
ST.TR
32.9°C
BS
COM.B
AS
COM.A
6.9KV
1SP
-3.96MW
6.813KV
COM
P.TR
SP
474.6V
1BT
460V
1B
P.TR
1BP
1BH
H.TR
25.7°C
1AH
1AP
1AT
6.9KV
-1.72MW
6.863KV
1A
P.TR
460V
466.5V
470.7V
26.2°C
0.005MW
EXC
0.0
A
31
800AT
BATTERY
41-1M
111
0-11
No.1
M.TR
26.4°C
0.00KV
0.01KA
60.00HZ
No.1
GEN

FIG. 18

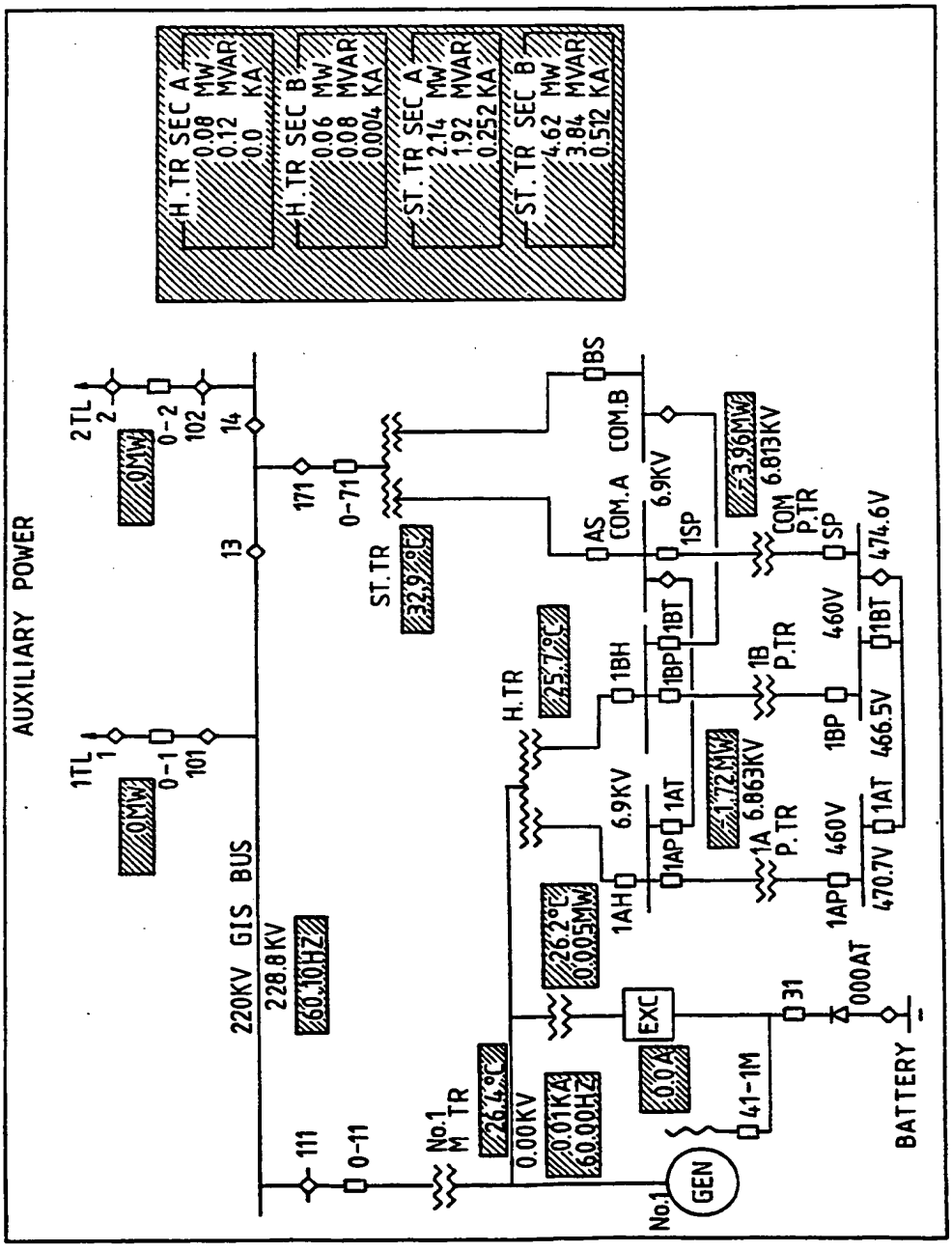

AUXILIARY POWER
H.TR SEC A
0.08 MW
0.12 MVAR
0.0 KA
H.TR SEC B
0.06 MW
0.08 MVAR
0.004 KA
ST.TR SEC A
2.14 MW
1.92 MVAR
0.252 KA
ST.TR SEC B
4.62 MW
3.84 MVAR
0.512 KA
2TL
2
0MW
0-2
102
14
171
0-71
ST.TR
32.9°C
BS
AS
COM.A
COM.B
6.9KV
1SP
3.96MW
COM
6.813KV
P.TR
SP
474.6V
1TL
1
0MW
0-1
101
13
H.TR
25.7°C
1BH
1BP
1BT
1B
P.TR
460V
220KV GIS BUS
228.8KV
60.10HZ
6.9KV
1AT
1AP
1AH
1.72MW
1A
6.863KV
P.TR
460V
1BP
466.5V
1BT
111
0-11
No.1
M TR
26.4°C
0.00KV
0.01KA
60.00HZ
26.2°C
0.005MW
EXC
0.0A
31
41-1M
1AP
460V
1AT
470.7V
000AT
BATTERY
No.1
GEN

FIG. 19

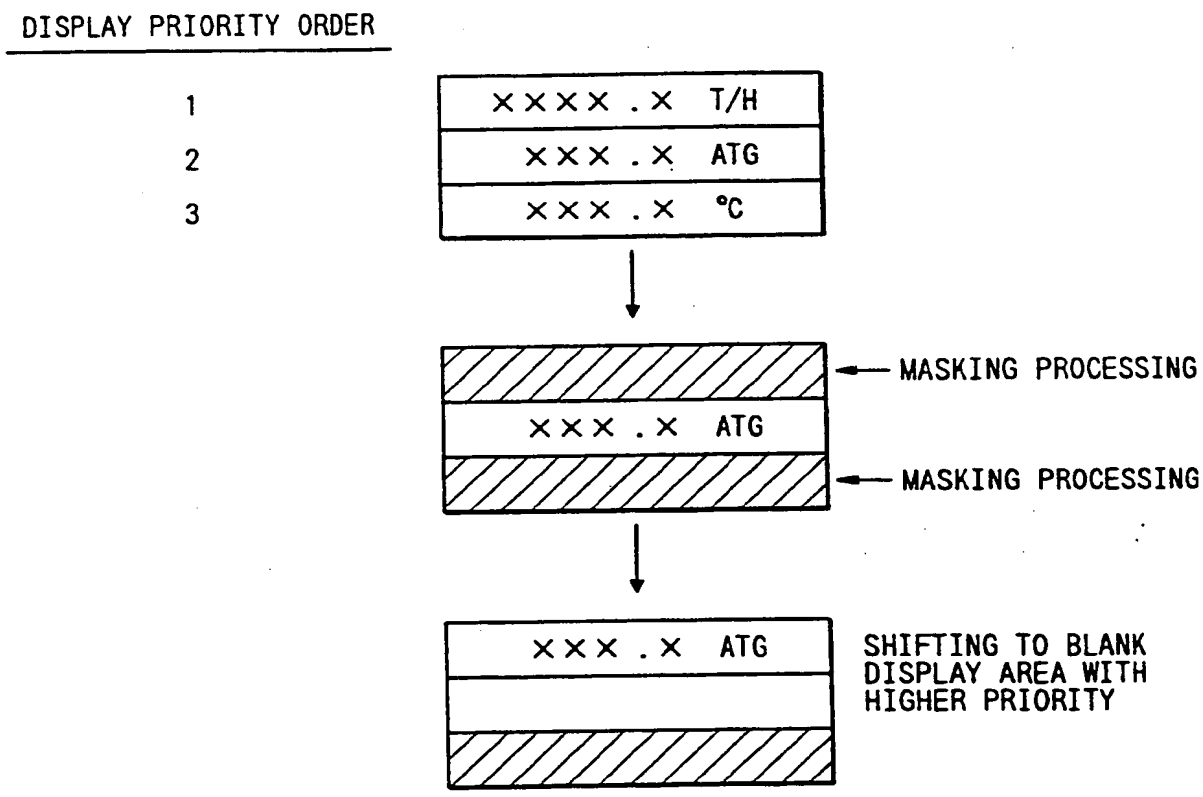

DISPLAY PRIORITY ORDER
1
2
3
XXXX.X T/H
XXX.X ATG
XXX.X °C
MASKING PROCESSING
XXX.X ATG
MASKING PROCESSING
XXX.X ATG
SHIFTING TO BLANK DISPLAY AREA WITH HIGHER PRIORITY

FIG. 20

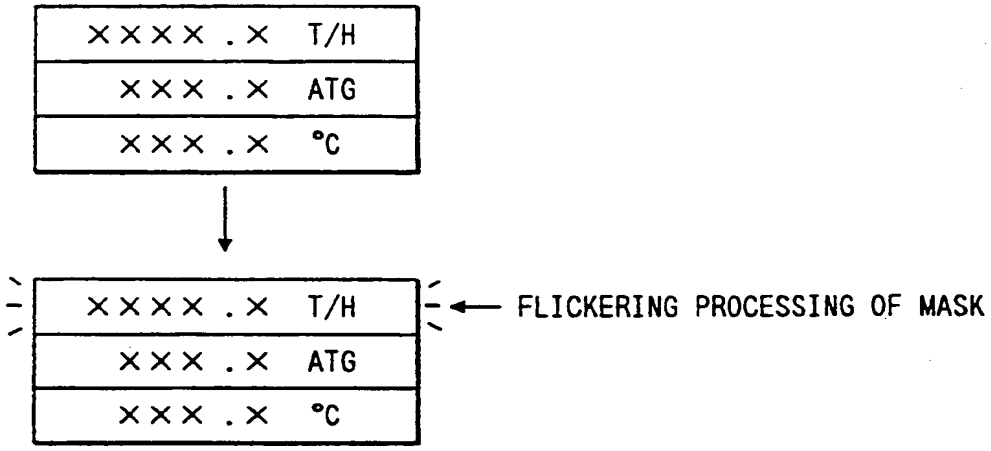


FIG. 21

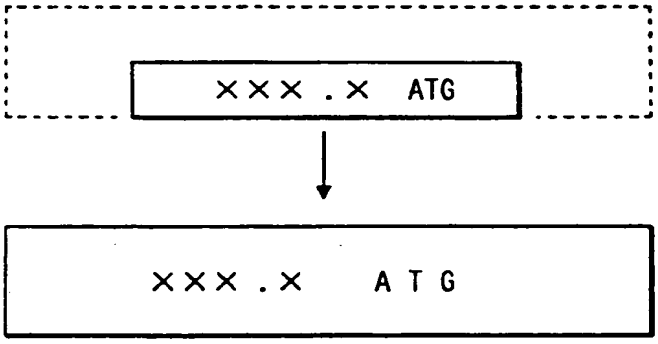


FIG. 22

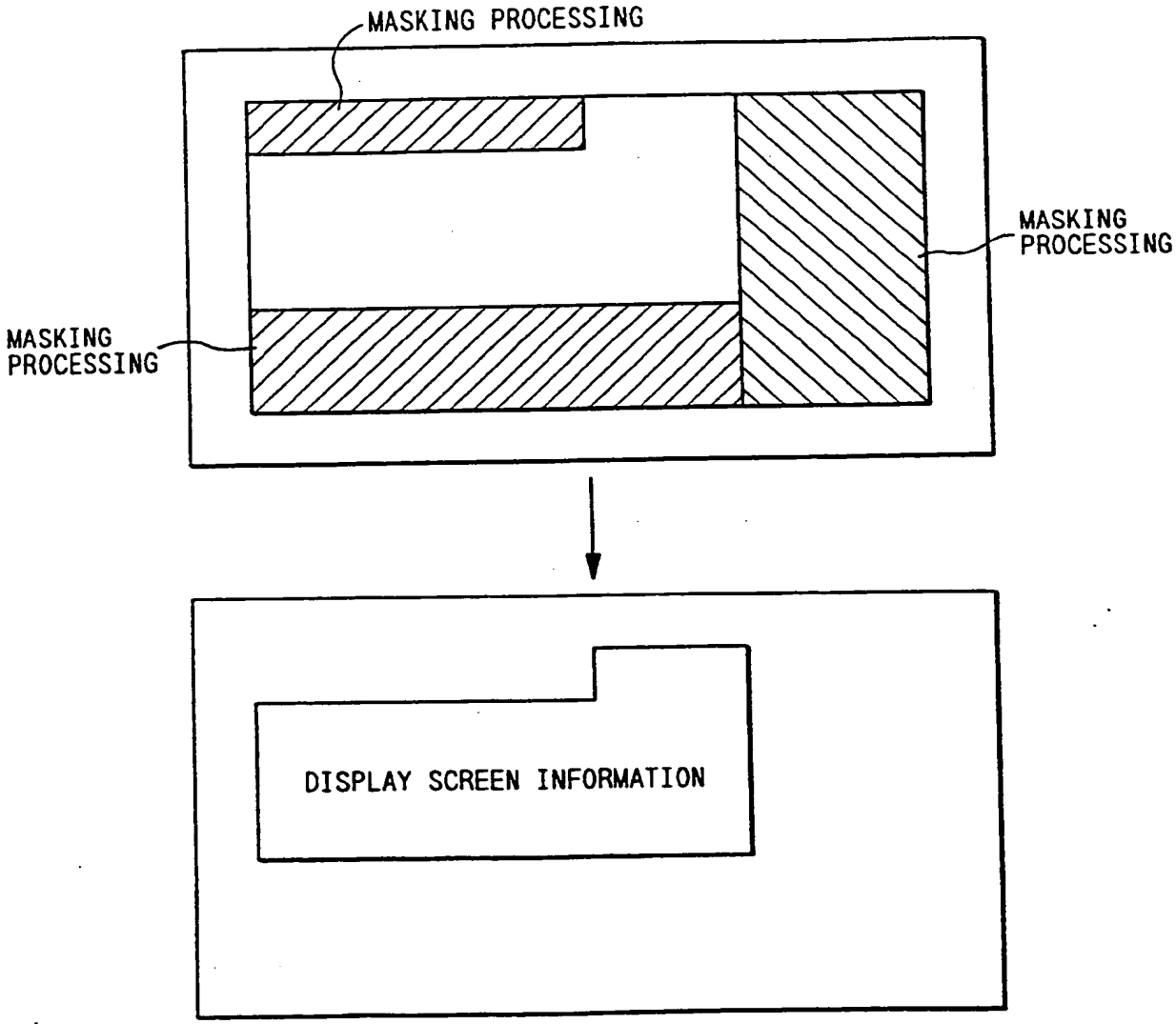
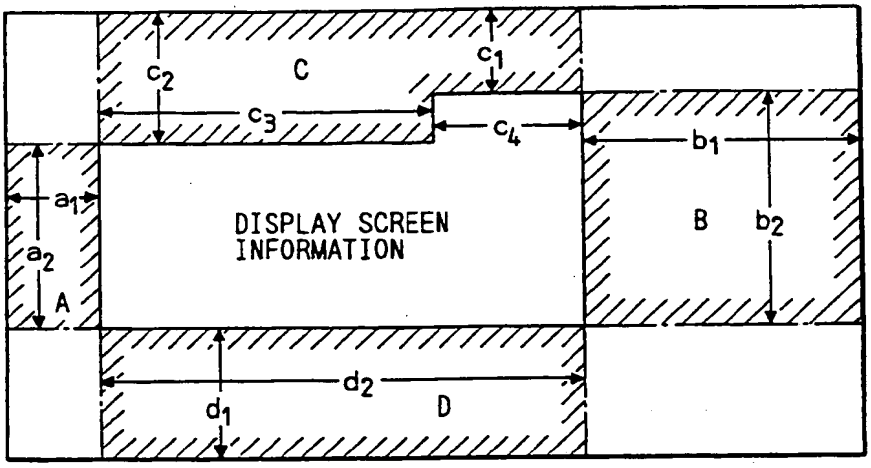

MASKING PROCESSING
MASKING PROCESSING
MASKING PROCESSING
DISPLAY SCREEN INFORMATION

FIG. 23

(a)



(b)

BALANCE ADJUSTMENT PROCESSING OF DISPLAY SCREEN	TO OBTAIN SUCH VALUES a_1, d_1 THAT HATCHED PART AREAS A, B, C, D BECOME AS UNIFORM AS POSSIBLE. (TO DISPLAY "DISPLAY SCREEN INFORMATION" AT THE BEST BALANCED POSITION.) --- $A \fallingdotseq B \fallingdotseq C \fallingdotseq D$, WHEREIN $A=a_1 . a_2$, $B=b_1 . b_2$, $C=c_1 . c_4+c_2 . c_3$, $D=d_1 . d_2$

(c)

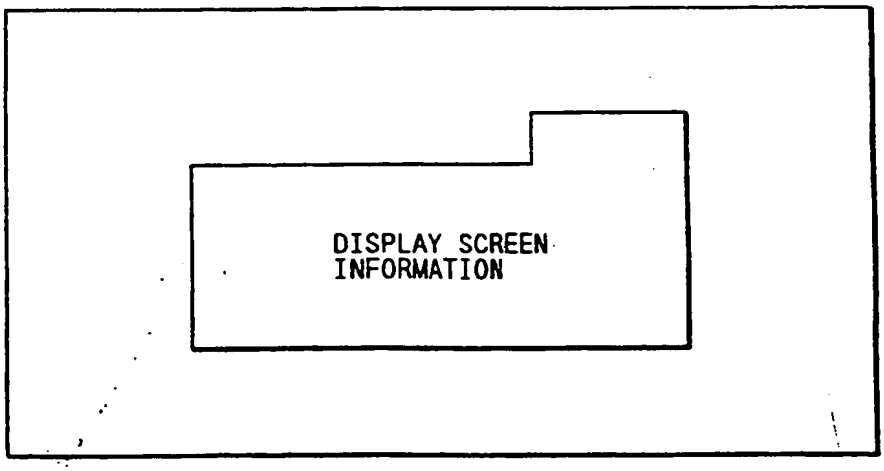


FIG. 24

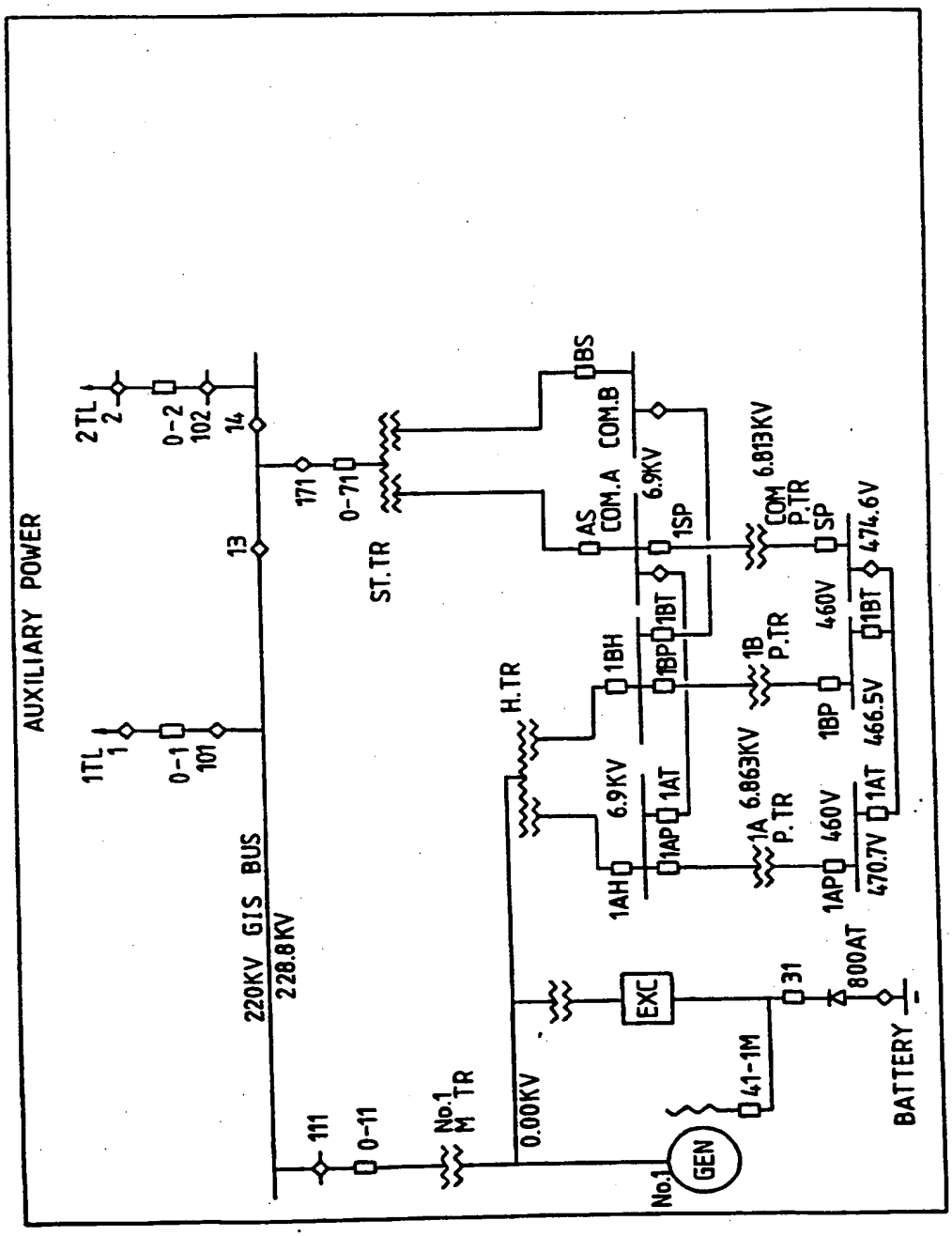

AUXILIARY POWER
220KV GIS BUS
228.8KV
1TL
1
0-1
101
2TL
2
0-2
102
14
13
171
0-71
ST.TR
BS
AS
COM.A
COM.B
6.9KV
1SP
COM
6.813KV
P.TR
SP
474.6V
1BT
1BH
1BP
H.TR
1B
P.TR
460V
6.9KV
1AT
1AP
1AH
1A
6.863KV
P.TR
460V
466.5V
470.7V
800AT
BATTERY
EXC
31
41-1M
111
0-11
No.1
M TR
0.00KV
No.1
GEN

FIG. 25

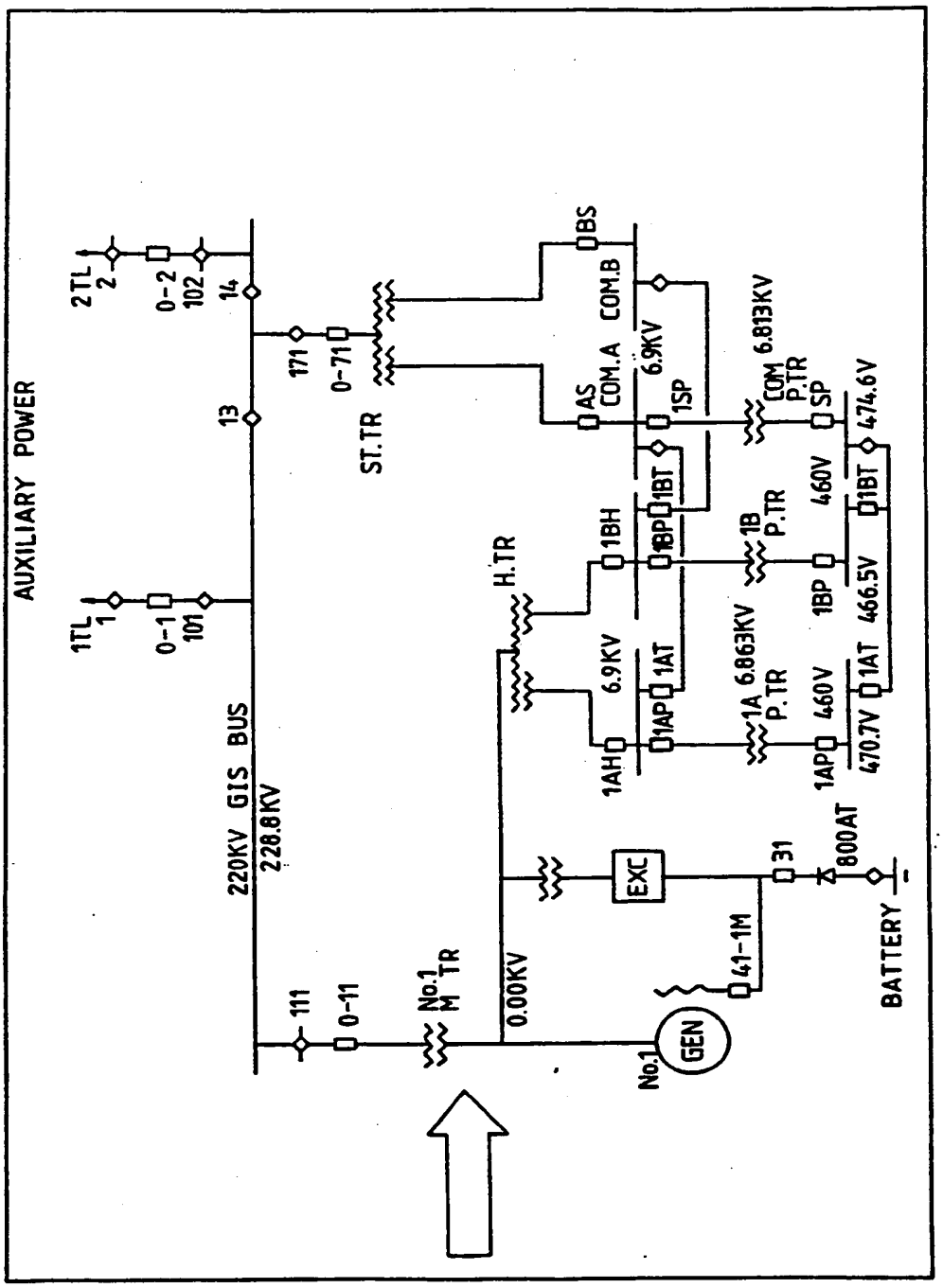
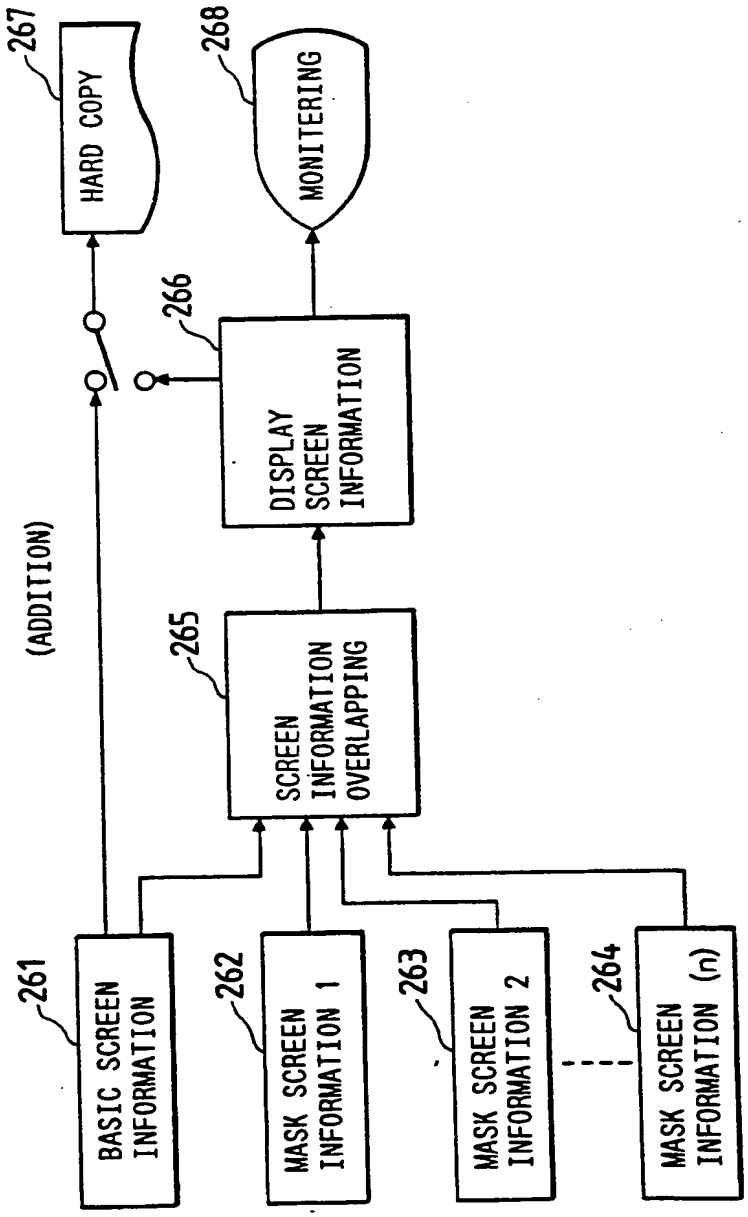

AUXILIARY POWER
2TL
2
0-2
102
14
171
0-71
13
ST.TR
BS
AS
COM.A
COM.B
6.9KV
1SP
COM
6.813KV
P.TR
SP
474.6V
1TL
1
0-1
101
1BH
1BP
1BT
H.TR
1B
P.TR
460V
1BT
220KV GIS BUS
228.8KV
6.9KV
1AT
1AP
1AH
1A
6.863KV
P.TR
460V
1BP
466.5V
1AT
470.7V
1AP
111
0-11
No.1
M TR
0.00KV
EXC
31
800AT
BATTERY
41-1M
No.1
GEN

FIG. 26


267
HARD COPY
268
MONITERING
266
DISPLAY SCREEN INFORMATION
(ADDITION)
265
SCREEN INFORMATION OVERLAPPING
261
BASIC SCREEN INFORMATION
262
MASK SCREEN INFORMATION 1
263
MASK SCREEN INFORMATION 2
264
MASK SCREEN INFORMATION (n)